CENTER LAKE DIAGNOSTIC STUDY REPORT

PREPARED FOR:

CENTER LAKE CONSERVATION ASSOCIATION, INC.
&
INDIANA DEPARTMENT OF NATURAL RESOURCES

PREPARED BY:

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Center Lake Conservation Association, Inc.

EXECUTIVE SUMMARY

V3 Consultants, Ltd. performed a watershed diagnostic study for the Center Lake Conservation Association and the Indiana Department of Natural Resources on Center Lake in Warsaw, Indiana. This study was funded by the Center Lake Conservation Association and the Indiana Department of Natural Resource's Lake and River Enhancement Program.

Warsaw has three lakes within it's city limits: Center Lake, Pike Lake and Winona Lake. Center Lake is approximately 120 acres and has a diagnostic study watershed of approximately 9,611 acres. The Center Lake watershed has many atypical hydrologic features due to alterations that have taken place with regard to manipulation of surface water connections. Water enters Center Lake from groundwater contributions and springs as well as from surface water contributions from Walnut Creek, Tippecanoe River and Lones Ditch. The water table is very high within Warsaw, as there are three lakes within the city limits (Center Lake, Pike Lake and Winona Lake). Groundwater recharge provides a significant recharge to the lakes. During times of highwater (storm event) conditions, the Tippecanoe River and Walnut Creek would become a surface water connection to Center Lake that is non-existent during normal flow conditions.

Water quality samples were collected from Center Lake, Walnut Creek, Tippecanoe River and Lones Ditch. The parameters included during water quality sampling include total phosphorus, total nitrogen ammonia, dissolved oxygen, pH, alkalinity, transparency, turbidity, conductivity, oxidation-reduction potential, and temperature. Additionally, historical chemical data obtained from the IDEM were used to evaluate the chemical changes that occurred in the lake throughout the years.

Water sample analysis from Center Lake suggests intense bacterial activities along the bottom of the lake. These indications are supported by a consistent pattern of higher concentrations of ammonium and very low dissolved oxygen concentrations in the hypolimnion. Additionally, consistent high concentrations of nutrients (total phosphorus and total nitrogen) in the bottom of the lake suggest that nutrients are released from the lake bottom sediments. This is common in eutrophic lakes that have decaying plant and algae settling out of the lake, which can result in low dissolved oxygen levels. The condition of low dissolved oxygen levels along the bottom of Center Lake could be improved by reducing the amount of nutrients (nitrogen and phosphorus) that are entering the lake that cause an increased growth of algae and aquatic plants.

Water sample analysis from the tributaries show that Walnut Creek maintains the highest concentrations of total phosphorus during both base flow and storm flow conditions. These total phosphorus concentrations are higher than the phosphorus concentrations at the surface of Center Lake. It is likely that high water flows from the Tippecanoe River and Lones Ditch contribute to excessive nutrient loads to Center Lake. This indicates that minimizing inflows from the tributaries may reduce the severity of nutrient loading impacts to Center Lake.

The information gathered as part of this study were analyzed and interpreted so that recommendations could be made to improve the water quality within Center Lake and it's watershed. These watershed improvement recommendations include:

1. Center Lake/Lones Ditch Connection Channel
   It is our recommendation that the flow gate to the Lones Ditch connector channel be closed at all times to prevent flow of water from Pike Lake into Center Lake. If flushing of this channel is desired by the Center Lake Association, it should only occur when the Center Lake water surface elevation is above the water elevation in the Lones Ditch connector channel. This will allow for water to flow out from Center Lake to the channel, and not allow pollutant inflow to occur.

   The historic flow paths of Center Lake have been changed dramatically. Center Lake was historically isolated from Pike Lake until the manmade connection occurred to Lones Ditch. This manmade connection to Lones Ditch has created an inflow of water, which carries additional pollution and sediment into Center Lake and has contributed to degraded water quality. The direct Center Lake tributary watershed is generally a small area immediately around the lake and including portions of Warsaw. However, because the manmade channels have been constructed to connect Pike Lake and Center Lake, a much larger tributary watershed influences the Center Lake water quality.

2. Walnut Creek Outlet Structure
   Operation policy for this structure should be adopted by the Center Lake Association Board to direct the appropriate actions for this flow gate structure. It is our understanding that the City of Warsaw owns this structure. It is necessary for the Center Lake Association and the City of Warsaw to come to an agreement for this operation plan and also implement this plan through City employees or Lake association volunteers.

   The inflow of water from Walnut Creek carries high levels of pollutants. During storm flow and high water conditions, Walnut Creek flood waters backflow into Center Lake. This flow of Walnut Creek floodwaters should be prevented. The manual flow gate between Center Lake and Walnut Creek should be closed when it is obvious that stormwater is entering Center Lake at this location.

3. Indiana Route 15 Storm Sewer
   It is recommended that a structural solution be implemented to filter the runoff that discharges to Center Lake. There are a variety of solutions that may be investigated for this problem including: vortex separator structures to remove sediment, trash, and oils from the stormwater runoff, sedimentation basins prior to discharge to the lake, connection of this storm sewer to a stormwater pump station which discharges downstream of Center Lake, or other feasible options.

   The storm sewer system from the Indiana State Route 15 is currently connected directly into Center Lake. This roadway is a state approved route for commercial tractor trailers. These commercial vehicles present the possibility of a catastrophic discharge of pollutants directly into Center Lake in the event of a gasoline spill, or other similar accident. Additionally, the maintenance procedures of the Indiana Department of Transportation includes a large amount of salt and sand to be placed on this roadway during the winter for control of snow and ice. This pollutant and sediment loading discharges directly into Center Lake.

4. <u>No Parking Sign on Island</u>
   The stormwater runoff from the roadway on Center Lake's island drains directly into the lake. When vehicles park on the island and roadway in order to access the lake for recreational fishing, it is creating a potential for contamination. The island roadway is utilized as more of a parking lot than a throughway. On repeated instances during wintertime ice-fishing activities, petroleum waste from an overabundance of vehicles has allowed a direct input of gas and oil into Center Lake. It is recommended that Center Lake Island be posted as No Parking, so that this potential point source pollution into the lake is eliminated.

5. <u>Improving Mechanical Weed Harvesting Protocol</u>
   Currently, the cut aquatic plant material is being disposed on the shoreline of Center Lake. One option is to consider an on-site disposal area that is not along the shoreline. This area might allow for periodic burning of the plant material with the necessary permits from the City of Warsaw. A second option is to identify a farmer that would be interested in spreading the cuttings over agricultural fields, utilizing the high nutrient content as fertilizer.

ADDENDUM:

CENTER LAKE
WATERSHED DIAGNOSTIC STUDY

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1.0 INTRODUCTION

1.1 Objectives

V3 Consultants, Ltd. (V3) has provided technical services to the Center Lake Conservation Association (CLCA) in conducting a watershed diagnostic study of Center Lake in Warsaw, Kosciusko County, Indiana. At the time of this study, Center Lake had shown signs of unusual proliferations of algae and of Eurasian water-milfoil. The study provided here follows the guidelines suggested by the Indiana Department of Natural Resources Lake and River Enhancement Program (LARE). The objectives of this diagnostic study are as follows:

- Describe the current conditions and historical trends within the Center Lake watershed.

- Identify potential threats to the quality of water in Center Lake

- Recommend lake and/or watershed management practices that minimize such threats.

The study was conducted in four different phases. First, V3 collected and reviewed available historical data and previous work, water chemistry data, precipitation and evaporation data in Kosciusko County, and aerial and topographic maps. This information was crucial in understanding the historical and current state of Center Lake and its watershed. Second, in May, July, and August 2003, V3 conducted lake survey events during which lake sampling, base flow sampling, and storm flow sampling activities were conducted in conjunction with tributary sampling activities. Additionally, lake shoreline and stream bank erosion data were collected and an evaluation of the lake's biological community was conducted. Third, a field survey was conducted that assisted the delineation of the Center Lake watershed for the purposes of this diagnostic study. Land use information was also compiled in order to construct a land use map for the Center Lake watershed. The fourth phase involved the analysis and interpretation of data collected in the previous phases of the study. Based on this assessment, recommendations were developed for improvement of conditions within Center Lake.

In order to comprehend the primary concepts that underlie this study and the nature of the processes observed in Center Lake, an understanding of processes that govern water bodies is necessary. Water bodies such as rivers and lakes can be classified according to their trophic state as: *oligotrophic* (poorly nourished), *mesotrophic* (moderately nourished), *eutrophic* (well nourished) and *hypereutrophic* (overly nourished). As part of the natural aging process, there is a normal progression from the oligotrophic state to the eutrophic state. This is due to the accumulation of nutrients over a long period of time. This natural process of eutrophication can be accelerated by several orders of magnitude as a result of human activities. The nutrients that are responsible for eutrophication are phosphorus and nitrogen. Evidence of eutrophication includes a decrease of clarity, absence of dissolved oxygen in the deeper water areas, and the abundance of blue-green algae.

Human activities affecting the quality of water bodies can be two-fold: lake related activities and watershed related activities. Lake related activities typically include lakes discharges from industrial processes, water treatment plants and/or septic systems, and the re-routing of the water to or from the lake for various purposes. These activities alter the natural inflow-outflow balance of the lake. Watershed related activities involve land use trends and changes in the physical and chemical characteristics of the watershed. A watershed is a delineated area with a well-defined topographic boundary and a water outlet (lake or rivers). Land use trends tend to change from heavily agricultural usage to more urban usage thus changing the chemical composition of runoff water tributary to the lake.

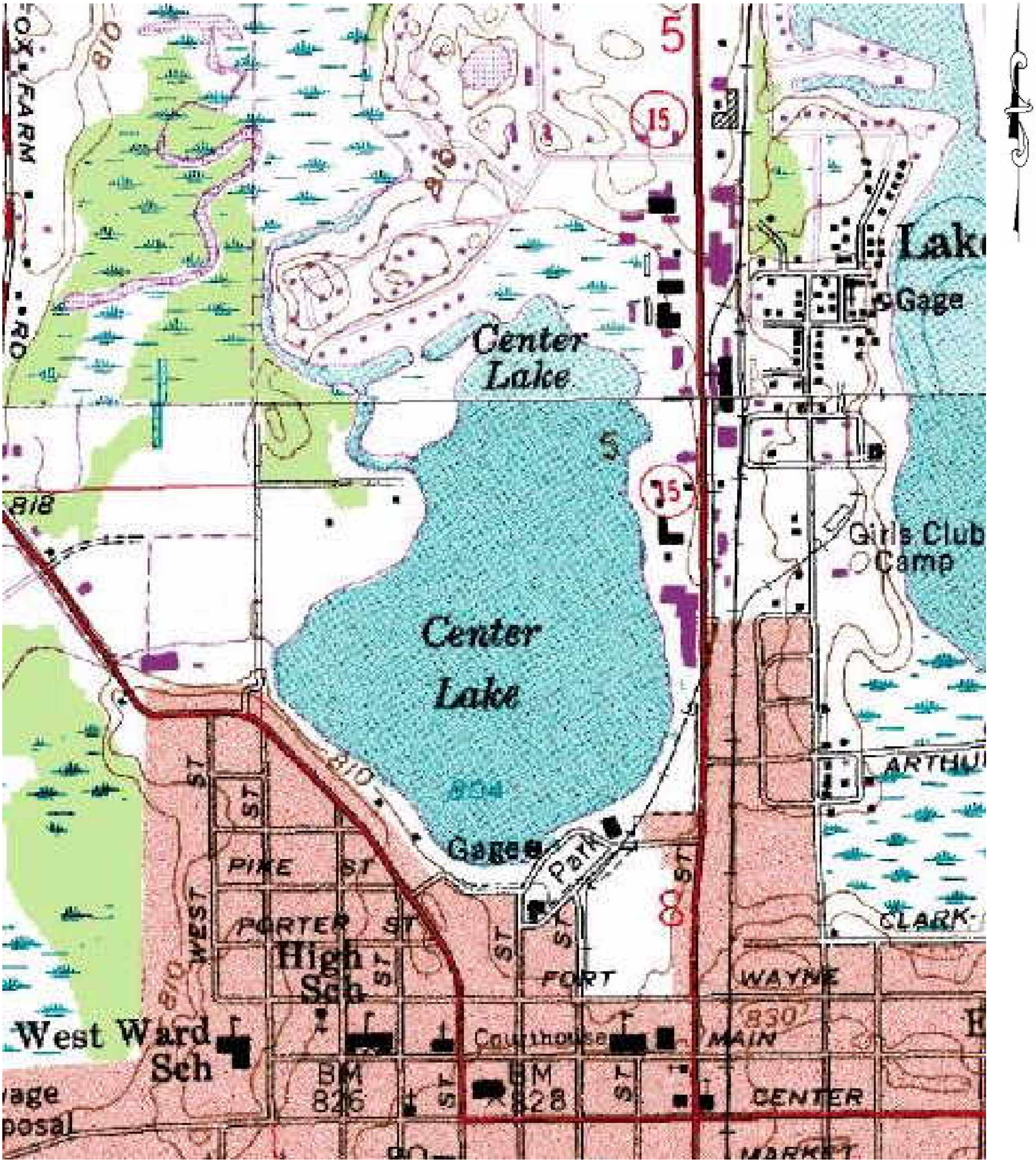
The direct tributary Center Lake watershed, as listed and defined by the United States Geological Survey (USGS), is a small (467 acres) largely urbanized area surrounding the lake. This watershed will be called the Direct Tributary Watershed throught this report. However, during threshold storm (flood) events, waters flow into Center Lake from tributaries (Tippecanoe River, Walnut Creek and Lones Ditch from Pike Lake). This additional complication has led us to define and delineate a broader watershed area (the overall Center Lake watershed) that includes Tippecanoe River, Walnut Creek and Center/Pike Lake watersheds. These combined watersheds define the maximum area of contribution for inflows to Center Lake. The entire inflow watershed will be described as the Overall Watershed throughout this report.

This study evaluates the effects that nutrient and sediment loads originating from both the largely urbanized direct tributary watershed area, as well as, the extended, and largely agricultural, overall watershed, have on the water quality of Center Lake. On this basis, various lake management recommendations have been made.

1.2 Location and Characteristics of Center Lake

Location and Physical Characteristics

Center Lake is located in Warsaw, Indiana, in Section 5, Township 32 North and Range 6 East (Leesburg Quadrangle) in Kosciusko County, Indiana. A topographic map of Center Lake is illustrated on Figure 1. The lake occupies an area of about 120 acres (0.19 square miles) with a maximum depth of 42 feet (12.8 meters). A lake volume was calculated to be approximately 1,680 acre-feet (2.07×10^6 m^3). The physical characteristics of Center Lake are summarized in Table 1.



Engineers • Scientists • Surveyors 7325 Janes Avenue, Suite 100 Woodridge, Illinois 60517 (630) 724-9200	Title: Center Lake Topographic Map	Project: Center Lake		
	Client: Center Lake Conservation Association	Project No. 02218	Figure: 1	Sheet: 1 Of: 1
		File Name: N/A	Effective Date: 1/08/04	Scale: NTS

TABLE 1 – PHYSICAL CHARACTERISTICS OF CENTER LAKE

Surface Area (acres)	120*
Volume (acres-feet)	1,680
Maximum Depth (feet)	42**
Direct Tributary Watershed Area (acres)	467*
Total Overall Center Lake Watershed (acres)	9,611***

* Source = USGS Data Report Water Year 2002
**Source = Indiana Department of Environmental Management
***= Calculated value based on V3 data review and field observations

Inflow
The primary tributary waters to Center Lake as reported by the USGS originate from the Tippecanoe River (Data Report, Water year 2002). However, under low flow conditions it appears that little if any contribution from the Tippecanoe River is realized. Under high flow conditions, it is apparent that waters flow into Center Lake from Walnut Creek, Tippecanoe River and Pike Lake via Lones Ditch.

Outflow
Center Lake discharges into Walnut Creek 0.65 miles downstream of the Center Lake West Control Dam. Walnut Creek in turn flows into the Tippecanoe River. Additionally, water flows from Center Lake out to Lones Ditch between the Pike Lake outfall and the Tippecanoe River. Lones Ditch flows towards the Tippecanoe River. It is unknown how much of the Lones Ditch flow enters Center Lake.

Chemical Characteristics
The water sampling parameters and analytical methods used for understanding the chemical characteristics of Center Lake were consistent with those used under the Indiana Department of Environmental Management (IDEM) sampling's program. Those parameters include total phosphorus, total nitrogen ammonia, dissolved oxygen, pH, alkalinity, transparency, turbidity, conductivity, oxidation-reduction potential, and temperature.

Water samples were collected from the surface (*epilimnion*) and from the bottom (*hypolimnion*) of Center Lake. The zone of abrupt temperature change between the warm *epilimnion* and the cool *hypolimnion* is called *the metalimnion*.

Water quality samples were also collected from Center Lake tributaries. Samples were collected from Walnut Creek, Tippecanoe River and Pike Lake (sample taken in Lones Ditch) under base and storm flows. Additionally, historical chemical data obtained from the IDEM were used to evaluate the chemical changes that occurred in the lake throughout the years.

The results of the current sampling and review of existing chemical are presented in Section 3.0 Lake Bioassessment.

1.3 Watershed Size and Topography

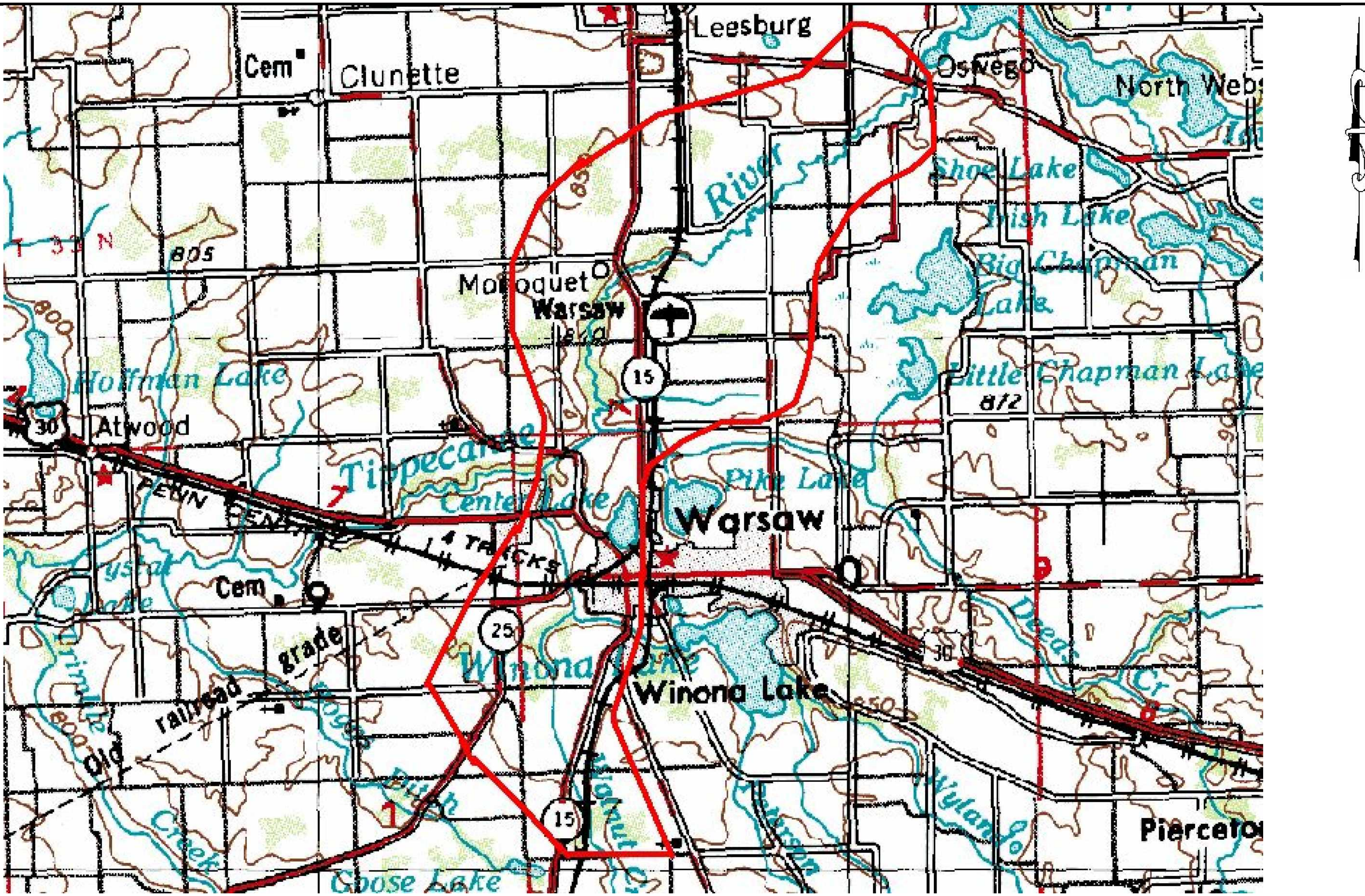
The size of the Center Lake watershed identified by the IDNR LARE program was 467 acres, which is the same as the watershed the USGS defines for Center Lake (Figure 2) in the hydrologic unit exhibit. This is referred to here after as the direct tributary watershed. Both of these identifications were determined by interpreting where precipitation would be directed based on topography and surface water connections.

As V3 became more familiar with the function of interconnections within the Center Lake watershed, it became clear that the highwater (storm event) conditions that occur in the Tippecanoe River and Walnut Creek would cause a surface water connection to Center Lake that was non-existent during normal flow conditions. With the influence of these periodic surface water contributions to Center Lake from both the Tippecanoe River to the north and Walnut Creek to the west, it became apparent additional areas should be added to the watershed that would reflect these periodic surface water contributions. Initially, the entire Tippecanoe River watershed upstream of Center Lake was proposed by V3 for inclusion, along with the entire Pike Lake and Winona Lake watersheds, and the entire Walnut Creek watershed. This proposed watershed area covered 27,514 acres and was clearly too large to provide an appropriate evaluation for the purposes of the diagnostic study and included areas already studied through the IDNR's LARE program. On December 19, 2002, CLCA members, LARE program staff and V3 staff met in Warsaw to discuss these issues. Through the interpretation of aerial photographs, topographic maps and a tour of key locations within the watershed, the appropriate size and components of the watershed were determined for this study.

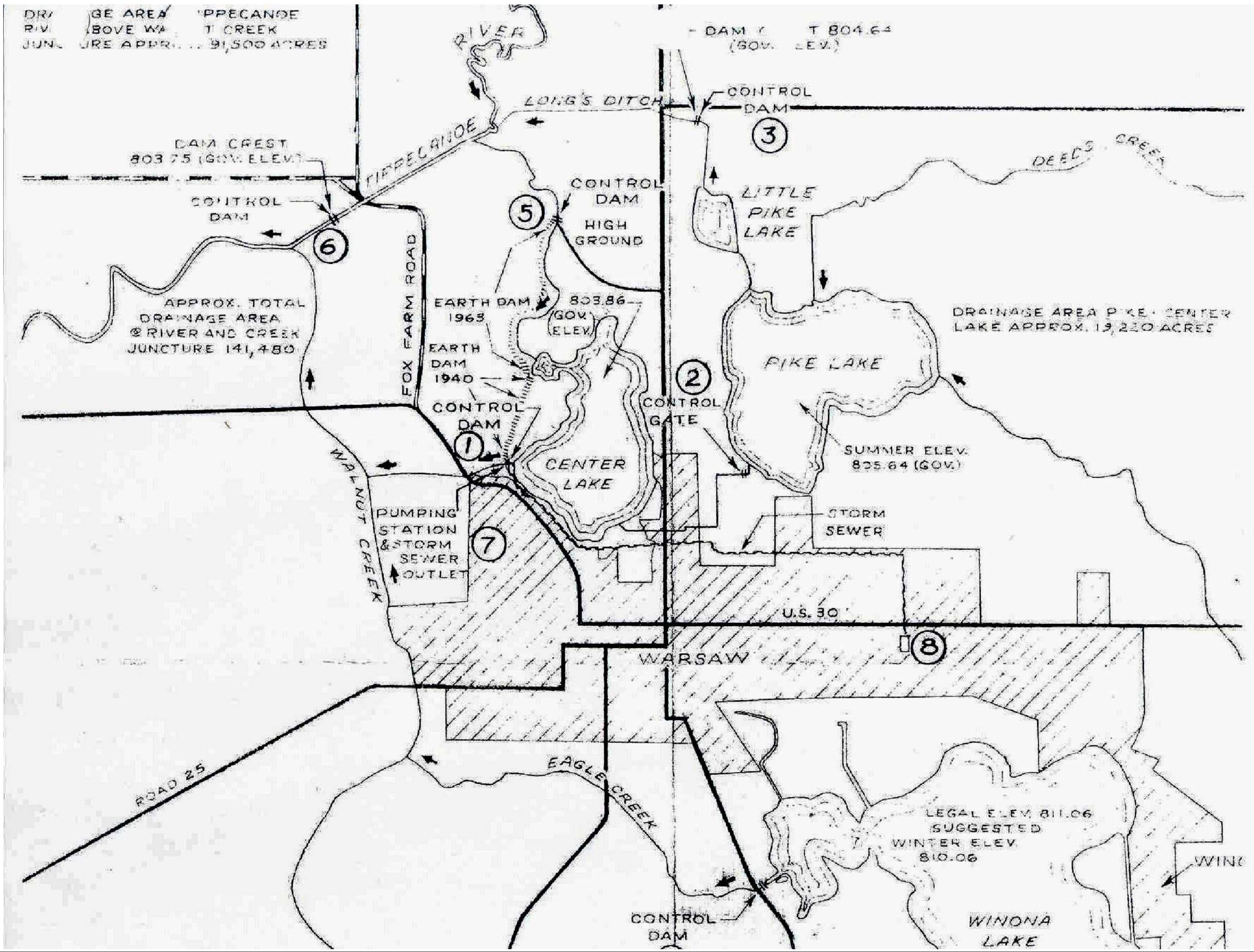
The agreed upon limits (boundaries) of the watershed to be used for the Center Lake diagnostic study included the entire area identified by the state and USGS (direct tributary watershed), plus the following additional areas: the Tippecanoe River watershed from the Lake Tippecanoe dam downstream to the confluence with Walnut creek, the Walnut Creek watershed upstream to its narrowest east-west cross point, and the entire stretch of Lones Ditch downstream of the Pike Lake outfall. This new watershed totaled 9,611 acres and is shown in Figure 3. This is referred to here after as the overall Center Lake watershed.

The Center Lake watershed has many atypical hydrologic features due to alterations that have taken place with regard to manipulation of surface water connections. Figure 4 shows several of the man-made alterations to the watershed. Figures 5 and 6 show the parts of the watershed as they existed in 1876. Most notably, the Tippecanoe River has been channelized and no longer converges with Walnut Creek and the Center Lake outfall just to the west of the south end of Center Lake. Walnut Creek now connects just downstream of the Fox Farm Road Crossing of the Tippecanoe River.

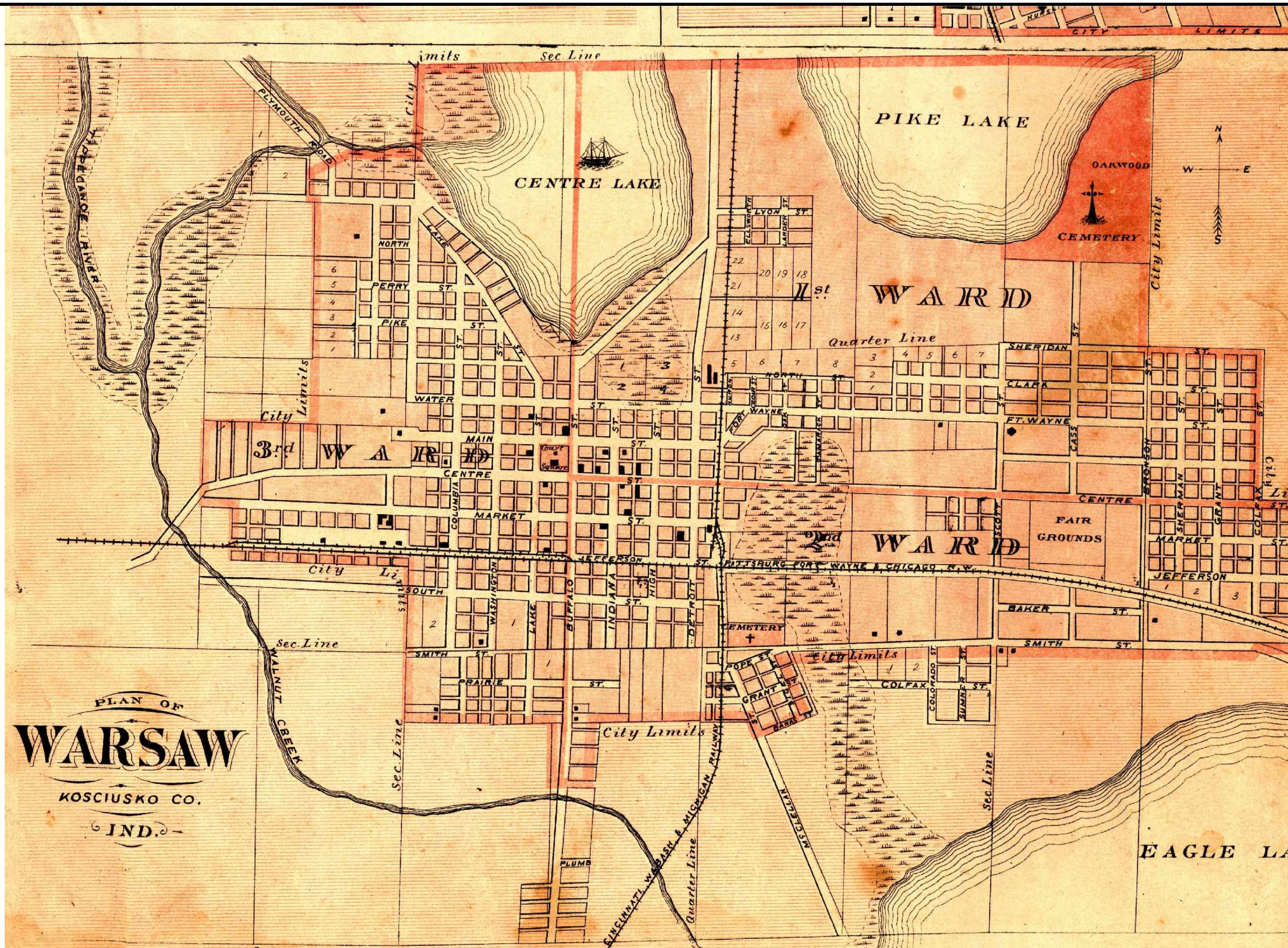
V3 CONSULTANTS Engineers • Scientists • Surveyors 7325 Janes Avenue, Suite 100 Woodridge, Illinois 60517 (630) 724-9200	Title: Hydrologic Unit Exhibit	Project: Center Lake		
	Client: Center Lake Conservation Association	Project No. 02218	Figure: 2	Sheet: 1 Of: 1
		File Name: N/A	Effective Date: 1/08/03	Scale: NTS



V3 CONSULTANTS	TITLE: Overall Watershed	PROJECT: Center Lake		
Consulting Engineers, Scientists, Surveyors	CLIENT: CENTER LAKE CONSERVATION ASSOCIATION	PROJECT NO. 02218	FIGURE: 3	SHEET: 1 OF: 1
7325 Janes Avenue, Suite 100 Woodridge, Illinois 60517 (630) 724-9200		FILE NAME: N/A	DATE: 1/07/04	SCALE: NTS



V3 CONSULTANTS	TITLE: Manmade Alterations	PROJECT: Center Lake		
Consulting Engineers, Scientists, Surveyors	CLIENT: CENTER LAKE CONSERVATION ASSOCIATION	PROJECT NO. 02218	FIGURE: 4	SHEET: 1 OF: 1
7325 Janes Avenue, Suite 100 Woodridge, Illinois 60517 (630) 724-9200		FILE NAME: N/A	DATE: 1/08/04	SCALE: NTS



V3 CONSULTANTS	TITLE: Historical Exhibit (1876)		PROJECT: Center Lake	
Consulting Engineers, Scientists, Surveyors	CLIENT: CENTER LAKE CONSERVATION ASSOCIATION	PROJECT NO. 02218	FIGURE: 5	SHEET: 1 OF: 1
7325 Janes Avenue, Suite 100 Woodridge, Illinois 60517 (630) 724-9200		FILE NAME: N/A	DATE: 1/07/04	SCALE: NTS

V3 CONSULTANTS	TITLE: Historical Exhibit (1876)	PROJECT: Center Lake		
Consulting Engineers, Scientists, Surveyors	CLIENT:	PROJECT NO. 02218	FIGURE: 6	SHEET: 1 OF: 1
7325 Janes Avenue, Suite 100 Woodridge, Illinois 60517 (630) 724-9200	CENTER LAKE CONSERVATION ASSOCIATION	FILE NAME: N/A	DATE: 1/07/04	SCALE: NTS

Watershed Size

The overall Center Lake watershed is comprised of three sub-watersheds: Center/Pike Lake, Tippecanoe River, and Walnut Creek. The Center/Pike Lake watershed consists of 888 acres and makes up 9% of the maximum area of contribution. The Tippecanoe River sub-watershed is 7,368 acres in area and makes up 77% of the maximum area of contribution. The Walnut Creek sub-watershed is 1,355 acres and makes up 14% of the maximum area of contribution.

The sub-watersheds were defined on the basis of the primary regions deriving potential inflows to Center Lake. In other words, the Tippecanoe sub-watershed represents the tributary area for periodic inflows from the Tippecanoe River that, during high water, entering Center Lake from the north. The Walnut Creek sub-watershed represents the tributary area for periodic high water inflows from Walnut Creek that enter Center Lake form the south. The Center/Pike Lake sub-watershed generally includes the direct tributary Center Lake watershed, plus a tributary area of Pike Lake (Lones Ditch) that periodically enters Center Lake. A map depicting the overall Center Lake watershed and different sub-watersheds is illustrated on Figure 7.

1.4 Legal Drains

There are multiple legal drains within the overall Center Lake watershed including: The drainage ditch which connects Center Lake to Walnut Creek (unnamed legal drain), the manmade channel connecting the northern side of Center Lake to Lones Ditch (unnamed legal drain), and the Lones Ditch. Each of these legal drains fall under the review and jurisdiction of the Kosciusko County Surveyor. Indiana statue IC 36-9-27 contains the County Drainage Code, which authorizes this regulation of the legal drains to the county surveyor.

The intent of the County Drainage Code is to provide hydraulic efficiency to control flooding and ponding through maintenance and construction activities within the legal drains. Funding is available for maintenance and reconstruction of the legal drains that are not functioning properly or have significant erosion and stabilization issues. If it is determined that modification of any of these legal drains would be required for improvement of water quality within Center Lake, approval would be required from the county surveyor and potential funding could be obtained for this purpose if the project met the intent of the drainage code.

1.5 Regulatory Floodplain

Center Lake is located within the regulatory floodplain associated with the Tippecanoe River and Walnut Creek flood sources. The approximate base flood elevation (BFE) for Center Lake is 808 according to the effective Flood Insurance Study (FIS), which is documented by the Federal Emergency Management Agency (FEMA). The flood hazard area is identified as Zone A2; Areas of 100-year flood with base flood elevations and flood hazard factors determined. The regulatory floodplain identifies the extent of the area inundated with water during the 100-year flood event, this area does not enhance or degrade water quality within the watershed. Attached in Appendix I are the FEMA Flood Insurance Rate Map (FIRM) panels for Kosciusko County, Indiana and Incorporated Areas. The FIRM panels 18085C0078 C and 18085C0086 C each display a portion of the floodplain associated with Center Lake. The effective date of these FIRM panels is February 4, 1987. The regulatory floodplain identifies the extent of the 100-year flood.

1.6 Climate

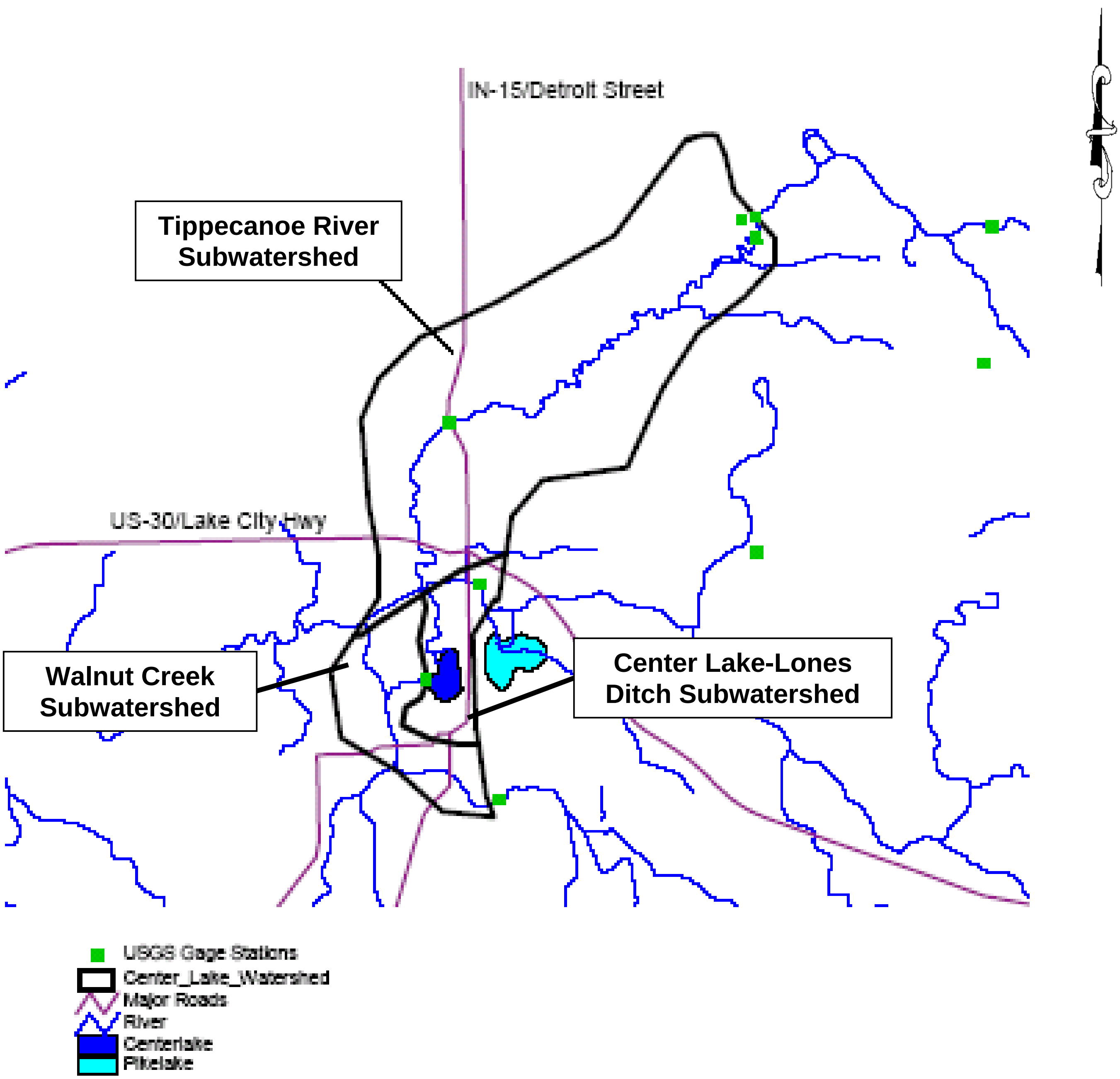
The climate in Warsaw, Indiana is characterized as cool and humid with snowy winters and hot summers. The average daily temperature is 49 degrees Fahrenheit. The summer average temperature is close to 70 degrees. The total annual precipitation is between 35 and 37 inches.

Kosciusko County is cold in the winter and quite hot in the summer. Winter precipitation, frequently snow, results in a good accumulation of soil moisture by spring and thus minimizes summer drought on most soils. The normal annual precipitation is adequate for all of the crops that are suited to the temperature and growing season in the county (SCS,1989).

In winter the average temperature is 26° F, and the average daily minimum temperature is 17° F. The lowest temperature on record, which occurred at Warsaw on January 16, 1972, is -25° F. In summer the average temperature is 70° F, and the average daily maximum temperature is 82° F. The highest recorded temperature, which occurred on both July 14 and 17, 1976, is 103° F (SCS, 1989 & MCC, 2003).

The total annual precipitation reported from 1951 to 1976 is 35.5 inches and from 1971 to 2000 is 36.65 inches. Approximately 60% of this precipitation falls in April through September. The growing season for most crops falls within this period. The heaviest 1-day rainfall, which occurred at Warsaw on September 16, 1958, is 5.67 inches. The average seasonal snowfall is approximately 26 inches for Kosciusko County as reported by the Soil Conservation Service from 1951 to 1976. This value is significantly lower as reported by the Midwest Climate Center from 1971 to 2000 for Warsaw as 11.7 inches. As the comparison of the total annual precipitation for this same time frame has an increase of 1 inch, this would indicate that there is slightly more annual precipitation even though there is 55% less annual snowfall. The greatest 1-day snowfall, which occurred at Warsaw on January 2, 1984, is 18.6 inches (SCS, 1989 & MCC, 2003).

The average relative humidity in mid-afternoon is about 60%. Humidity is higher at night, and the average at dawn is about 80%. The sun shines 70% of the time possible in summer and 40% of the time possible in the winter. The prevailing wind is from the southwest. Average wind speed is highest in spring at 12 miles per hour. Tornadoes and severe thunderstorms occur occasionally. These storms are usually local in extent and of short duration and cause damage in scattered areas (SCS 1989).



V3 CONSULTANTS Consulting Engineers, Scientists, Surveyors 7325 Janes Avenue, Suite 100 Woodridge, Illinois 60517 (630) 724-9200	TITLE: **SUBWATERSHEDS**	PROJECT: **CENTER LAKE**		
	CLIENT: **CENTER LAKE Conservation Association**	PROJECT NO. 02218	FIGURE 7	SHEET: 1 OF: 1
		FILE NAME: N/A	DATE: 01/08/04	SCALE: NTS

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Table 2 provides temperature and precipitation data for Warsaw.

TABLE 2 – HISTORICAL CLIMATE DATA, WARSAW, INDIANA, 1971-2000
(Source: Midwest Climate Center, 2003 and Times Union, August 15, 1972)

Month	**Maximum Temperature (°F)**	**Minimum Temperature (°F)**	**Mean Temperature (°F)**	**Mean Precipitation (in)**	**Mean Snowfall (in)**
January	30.7	14.9	22.8	1.85	5.8
February	35.3	18.1	26.7	1.45	1.5
March	46.9	28.1	37.5	2.08	0.8
April	58.6	37.8	48.2	3.36	0.2
May	70.5	48.7	59.6	3.83	0.0
June	78.9	57.8	68.4	4.51	0.0
July	82.2	62.1	72.2	3.67	0.0
August	79.6	60.3	70.0	4.05	0.0
September	73.4	52.6	63.0	3.22	0.0
October	61.5	41.5	51.5	3.04	0.0
November	47.9	31.8	39.9	2.97	0.0
December	35.3	21.2	28.3	2.62	3.1
Monthly Mean	58.4	39.6	49.0	-	-
Annual Total	-	-	-	36.65	11.7

1.7 Trends in Land Development

Aerial photos were used to review the general trends in land use and development within the City of Warsaw in the near vicinity of Center Lake. Aerial photos of Center Lake and immediately surrounding areas from 1974, 1985, and 2003 were obtained from the Kosciusko County surveyor. This area is largely urbanized. The available photos indicate the area south of the lake has been and is still more urbanized than the area north of the lake. The area immediately east of the lake has been heavily industrialized since the 1980's and continues to develop as such. The area west of the lake has been and remains largely residential. The area north of the lake has been and remains mainly forest land and cropland pastures. Because the near vicinity of Center Lake is largely urbanized, extensive modifications to land use are not anticipated.

Aerial maps from 1974, 1985 and 2003 are located in Appendix II. Table 3 lists the numbers of homes, businesses and commercial sites along the shoreline of the lake and channel, as surveyed on August 19, 2004 by V3 and CLCA.

TABLE 3 – Building Count Along the Shorelines of Center Lake and It's Channels, 2004

	Lakeside	Channelside
Single Family Residential	36	27
Multifamily Residential	1	8
Business	7	-
Utility	1	-
Industrial	1	-
Recreational	3	-

1.8 Unique Recreational Resources

The City of Warsaw has a managed public swimming beach, which is located along the south shore of Center Lake. Center Lake has one public boat launch also located along the south shore of the lake. The City of Warsaw owns approximately 18 acres of land along the south shore which includes the beach, boat launch, pavilion, two public gardens and open space for picnicking and other leisure outdoor activities. The parks are posted with No Feeding Wildlife signage. This will prevent nuisance wildlife situations from becoming problematic.

Center Lake possesses a powerboat restriction, which limits the horsepower that boats can use on the lake. There is no waterskiing or jetskiing allowed on the lake. The posted maximum speed for the lake is 10 mph. For the most part, Pontoon Boats and fishing boats are the two most utilized recreational activity. Frequent canoeing and kayaking activities also take place on the lake. There is an occasional windsurfing recreational activity use. Table 4 shows the boat counts that were recorded during CLCA volunteer monitoring.

The Center Lake Wetland Conservation Area is located on the northwest side of the lake. This 25-acre area has the following permitted public uses: trapping and fishing within the state seasons, hiking, nature study and berry picking. Hunting is not permitted as this area is within the Warsaw City Limits.

Table 4.
Volunteer Lake Monitoring Data Sheet
Center Lake Conservation Association
Center Lake, Warsaw, Indiana

Lake ID	Observation Date	Observation Time	Observation Day of Week	Secchi Disk Depth feet' inches"	Water Color	Comments	Boats Counted
43-00-04	**4/27/03**	**3:59 PM**	**Sunday**	**8' 4"**	**16**	First Reading, N wind, good fishing, sunny day, small ripples	**1**
43-00-04	**5/31/03**	**3:29 PM**	**Saturday**	**8' 2"**	**16**	SW wind, sunny day, **1st** chlorophyll / phosphorous reading, light ripples	**2**
43-00-04	**6/14/03**	**1:02 PM**	**Saturday**	**9' 8"**	**5**	EW wind, hazy / sunny day, light ripples	**4**
43-00-04	**6/17/03**	**5:30 PM**	**Tuesday**			Boat Count Only	**8**
43-00-04	**6/22/03**	**2:41 PM**	**Sunday**	**6' 5"**	**6**	NE wind, sunny day –nice day, light ripples	**8**
43-00-04	**6/29/03**	**2:59 PM**	**Sunday**	**4' 7"**	**16**	NE wind, rain / sunny day, **2nd** chlorophyll / phosphorous reading, heavier ripples	**6**
43-00-04	**6/30/03**	**1:01 PM**	**Monday**			Boat Count Only	**4**
43-00-04	**7/2/03**	**7:45 PM**	**Wednesday**			Boat Count Only	**4**
43-00-04	**7/12/03**	**2:19 PM**	**Saturday**			Boat Count Only	**8**
43-00-04	**7/13/03**	**11:12 AM**	**Sunday**	**5' 6"**	**16**	Beautiful day, glass surface, loose bodies (particles) floating in water	**3**
43-00-04	**7/31/03**	**12:37 PM**	**Friday**	**3' 1'**	**10**	N wind, hazy sunny day, **3rd** chlorophyll / phosphorous reading, heavier ripples	**2**
43-00-04	**8/9/03**	**2:30 PM**	**Saturday**	**3' 7"**	**10**	S wind, heavier ripples	**1**
43-00-04	**8/17/03**	**1:11 PM**	**Sunday**	**5' 2"**	**16**	S wind, sunny day, light ripples	**2**
43-00-04	**8/22/03**	**2:30PM**	**Friday**	**4' 6"**	**17**	S wind, mid 80's, beautiful day, light ripples	**2**
43-00-04	**8/30/03**	**2:14 PM**	**Saturday**	**6' 0"**	**12**	NW wind, sunny day, low humidity, **4th** chlorophyll / phosphorus reading, hight water (2 ft), heavier ripples	**3**
43-00-04	**9/6/03**	**11:32 AM**	**Saturday**			Boat Count Only	**8**
43-00-04	**9/7/03**	**12:52 PM**	**Sunday**	**5' 5"**	**17**	no wind, sunny day, mid 70's, glass surface	**3**

Center Lake Conservation Association, Volunteer Lake Monitoring Data Sheet 2/6/2004, Center Lake, Warsaw IN.

2.0 CURRENT WATERSHED CONDITIONS

2.1 Watershed Boundaries

The watershed boundary that was agreed upon as a result of the December 19, 2002 meeting totaled 9,611 acres. This watershed was divided into three subwatershed: Center Lake/Lones Ditch, Tippecanoe River, and Walnut Creek. The Center Lake/Lones Ditch sub-watershed consists if 888 acres and makes up 9.23% of the maximum area of contribution. The Tippecanoe River sub-watershed is a 7,368 acres area that makes up 76.67% of the maximum area of contribution. The Walnut Creek sub-watershed is a 1,355 acres area that makes up 14% of the maximum area of contribution.

2.2 Soils

The parent materials for forming soils were deposited in Kosciusko County by glaciers or by their meltwaters. Parent materials are the unconsolidated mass in which a soil forms. Some of these materials were reworked or redeposited by the subsequent actions of water and wind. The most recent glaciers covered Kosciusko County approximately 12,000 to 15,000 years ago. The dominant parent materials in Kosciusko County are glacial till, outwash deposits, lacustrine deposits, alluvium and organic material. Figure 8 sheet 1 of 4 shows the NRCS soil survey map for the overall Center Lake watershed. Figure 8 sheet 4 of 4 shows the soil survey legend.

<u>Glacial Till</u>
Glacial till is material laid down by glaciers with a minimum of water action. It consists of particles of different sizes that are mixed together. The small pebbles in glacial till have sharp corners, indicating that they have not been worn by water. The glacial till in Kosciusko County is calcareous, friable or firm fine sandy loam, sandy loam, loam or clay loam. Miami soils are an example of soils that formed in glacial till.

<u>Outwash Deposits</u>
Outwash deposits were placed by running water from melting glaciers. The size of the particles that make up outwash varies, depending on the velocity of the water that carried the material. When the water slowed down, the coarser particles were deposited. Finer particles, such as very fine sand, silt and clay, were carried farther by the more slowly moving water. Outwash deposits generally occur as layers of similar-size particles, such as sandy loam, sand, gravel and other coarse particles. Kosciusko soils are an example of soils that formed in outwash material.

<u>Lacustrine Deposits</u>
Lacustrine deposits were placed by still or ponded glacial meltwater. Only the finer particles such as very fine sand, silt and clay remained to settle out in still water. Lacustrine deposits are silty or clayey. The soils in Kosciusko County that formed in these deposits are medium textured to fine textured. Toledo soils are an example of soils that formed in lacustrine material.

<u>Alluvium</u>
Alluvium was recently deposited by floodwater along present streams. This material varies in texture, depending on the speed of the water from which it was deposited. Shoals and Saranac are examples of soils that formed in alluvium.

Organic Material

Organic material occurs as deposits of plant remains. Water was left standing by the glaciers in depressions on outwash plains, lake plains and till plains. Grasses and sedges growing around the edges of these lakes died, and their remains fell to the bottom of these water bodies. These plant remains did not decompose but remained around the edge of these water bodies. Later, white-cedar and other water tolerant trees grew in the areas. As these trees died, their remains became part of the organic accumulation. The water bodies were eventually filled with organic material, which developed into peat. In some areas the plant remains subsequently decomposed into muck. Houghton soils are an example of soils that formed in organic material (SCS, 1989).

Highly Erodible Soils

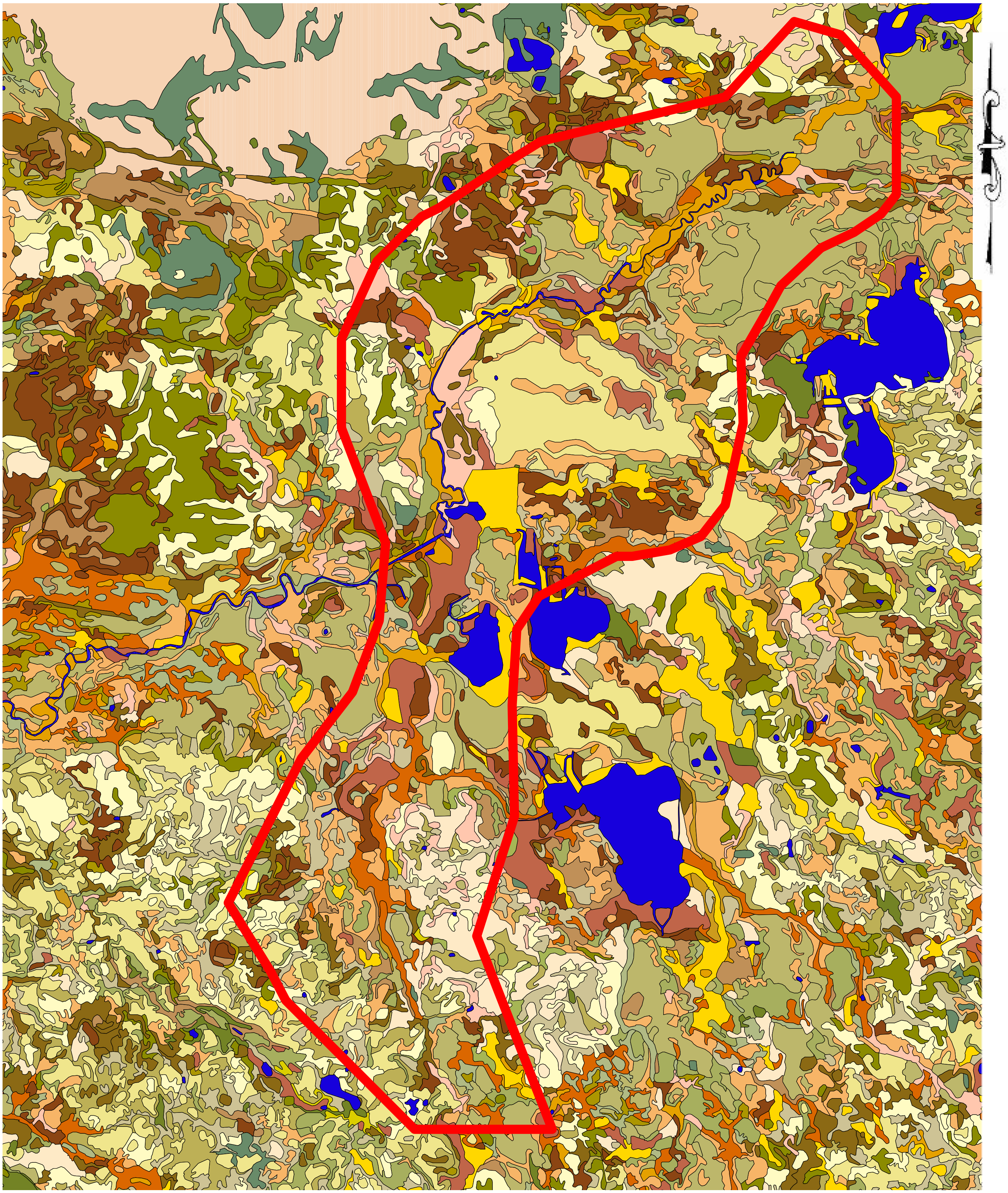
In a detailed study of lakes in Kosciusko County, Hippensteel (1989) found that approximately 35.5% of the Center Lake watershed is mapped as highly erodible soil. Additionally, 30% of Kosciusko County is mapped as highly erodible soils (United States Department of Agriculture Natural Resource Conservation Service- Sam St. Clair). The Highly Erodible Land (HEL) soils list for Kosciusko County includes eight types of soils: Kosciusko KoE; Miami MrC3 and MrD3; Morley MvC, MxC3 and MxD3; Riddles RID; and Wawasee WlDz (NRCS 2004).

Of these eight HEL's present in Kosciusko County, the overall Center Lake watershed has four HEL's which encompass approximately 56 acres and the direct tributary watershed has none, see Figure 8 sheet 2 of 4.

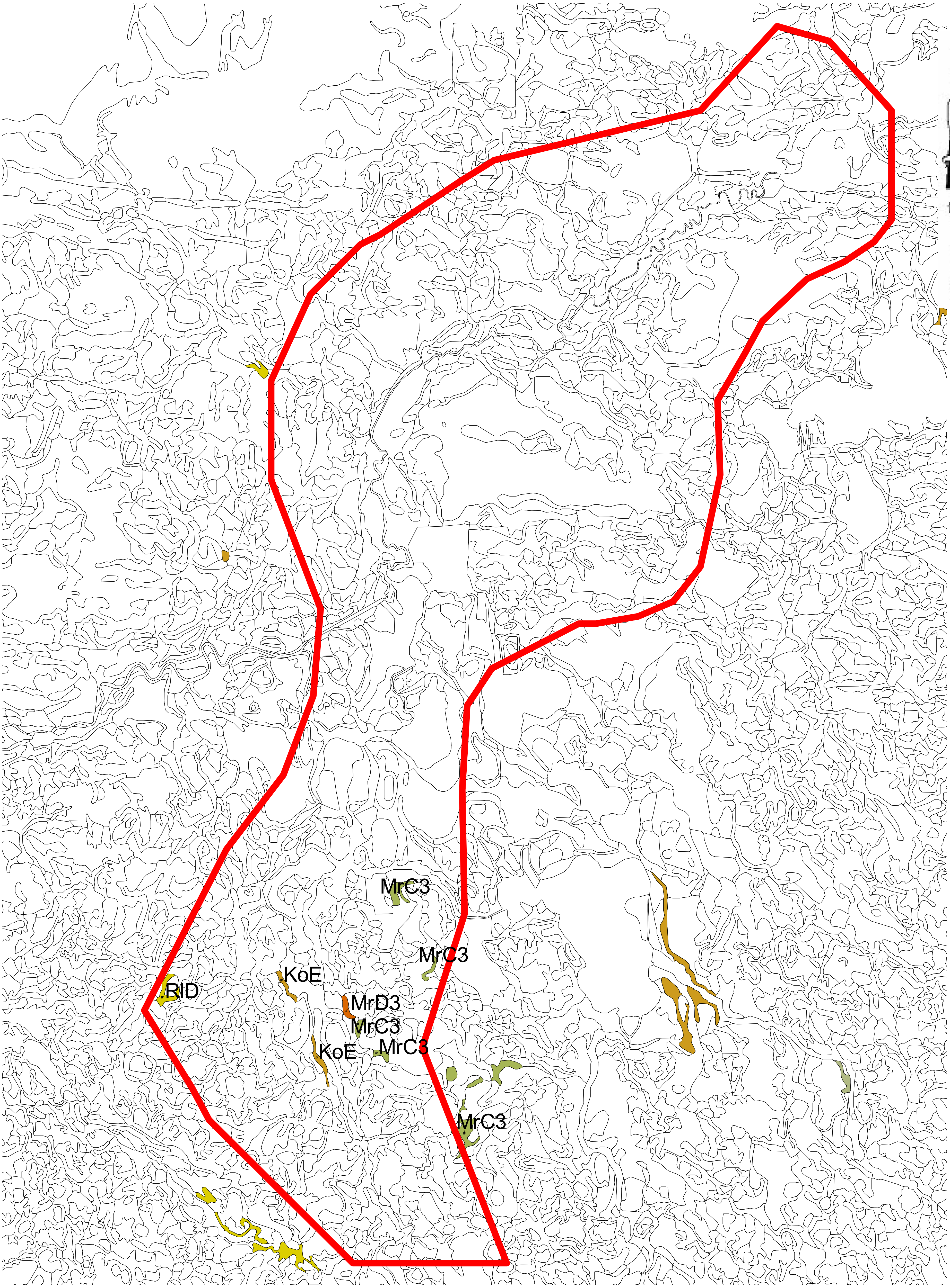
Septic Tank Absorption Fields

The ability of a soil to support a septic tank absorption field is dependant on gradual seepage of wastewater into the surrounding soils. This can easily be achieved where favorable soil characteristics and geology exist. In the situations where unfavorable conditions exist, either the seepage of wastewater is too fast or too slow, then modifications may be made to the location where the septic tank absorption field is to be placed. For example, mounds may be used in areas that are too wet. The Kosciusko County Health Department is able to assist landowners with these situations. The Soil Survey of Kosciusko County rates soil types as severe, moderate or slight for suitability of areas for septic tank adsorption fields.

Figure 8 sheet 3 of 4 shows the soils in the overall Center Lake watershed that are listed as suitable for septic tank absorption fields. Approximately 280 acres of the overall Center Lake watershed are suitable for septic tank absorption fields. Design modifications will be needed in most of the overall watershed (approximately 9,330 acres) as these areas have soils that are rated as severe or areas where the soils have inclusions that are rated as severe.



CONSULTANTS Engineers • Scientists • Surveyors 7325 Janes Avenue, Suite 100 Woodridge, Illinois 60517 (630) 724-9200	Title: NRCS Soil Survey Map	Project: Center Lake	
	Client: Center Lake Conservation Association	Project No. 02218	Figure: 8	Sheet: 1 Of: 4
		File Name: N/A	Effective Date: 09/13/04	Scale: NTS



![V3 Consultants logo]

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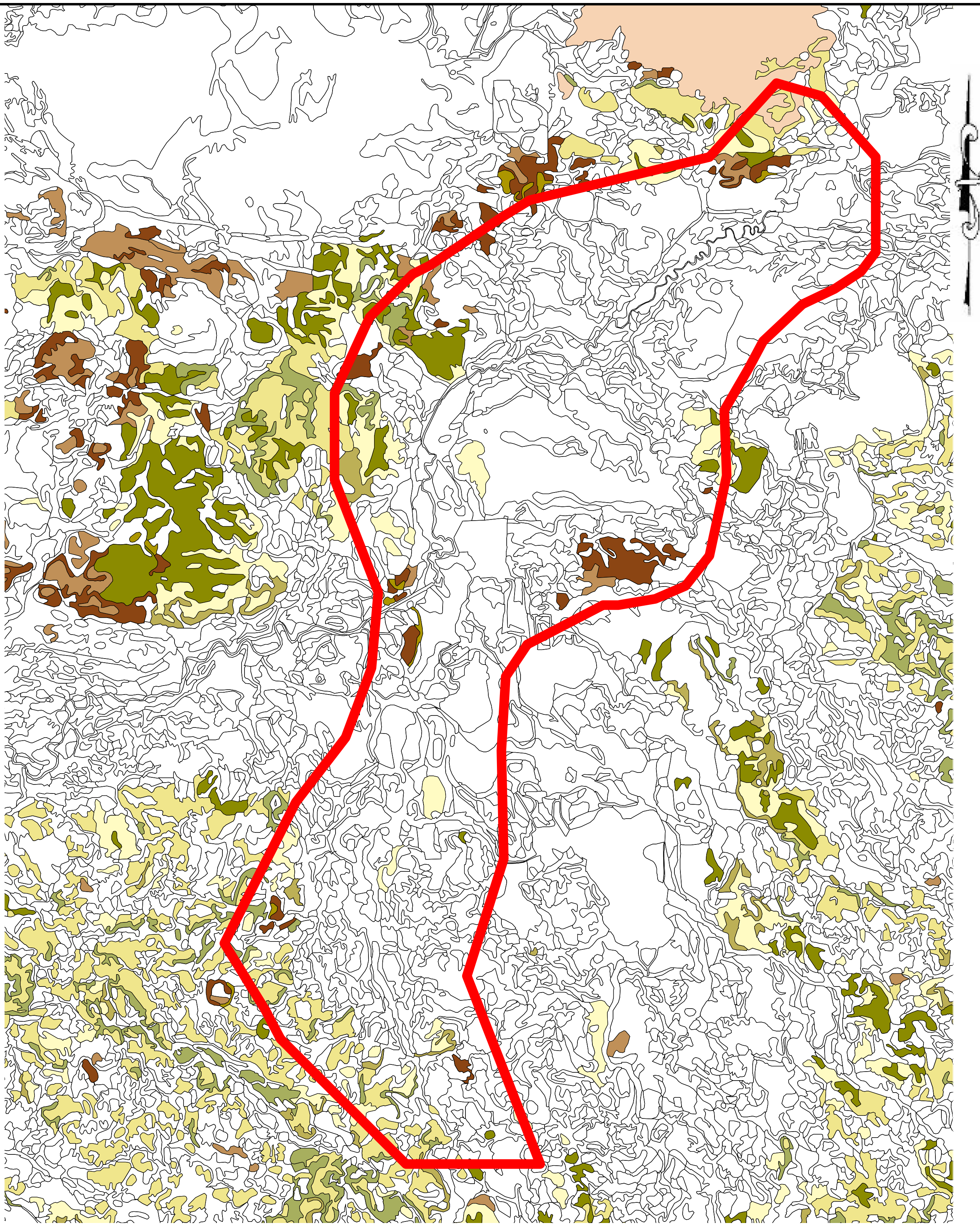
Title: Highly Erodible Lands	Project: Center Lake		
Client: Center Lake Conservation Association	Project No. 02218	Figure: 8	Sheet: 2 Of: 4
	File Name: N/A	Effective Date: 09/13/04	Scale: NTS



V3 CONSULTANTS Engineers • Scientists • Surveyors 7325 Janes Avenue, Suite 100 Woodridge, Illinois 60517 (630) 724-9200	Title: Septic Tank Absorption Fields Soil Suitability Map	Project: Center Lake		
	Client: Center Lake Conservation Association	Project No. 02218	Figure: 8	Sheet: 3 Of: 4
		File Name: N/A	Effective Date: 09/13/04	Scale: NTS

Soil Survey Legend:

Ab
Ao
ArA
AtA
Bc
BlA
BnB
BoB
BoC
Bp
BrA
CaA
ClB
ClC
CrA
CrB
De
Ed
Gf
Gm

Go
Gr
GtA
He
Ho
Ht
Hx
KoA
KoB
KoC
KoE
KtA
KxC3
MaA
MaB
MaC
MbA
MbB
MbC
MeA

MeB
MeC
MlB
MlC
MrC3
MrD3
MsB
MsD
MvC
MxC3
MxD3
MzB
OrA
OrB
OrC
OtA
OtB
OtC
Pa

Pb
Pe
Pg
Re
RlA
RlB
RlC
RlD
RxB
RxC
Sa
Se
Sf
ShA
ShB
Sn
To
Ud

Uf
Wa
Wc
We
WlB
WlC2
WlD2
Wt
w

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Title: NRCS Soil Survey Map

Project: Center Lake

Client: Center Lake Conservation Association

Project No.	Figure:	Sheet: 4 Of: 4
02218	8	
File Name: N/A	Effective Date: 09/13/04	Scale: NTS

2.3 Land use

The direct tributary Center Lake watershed as defined by the USGS is a largely urban area. Aerial photos show residential areas to the west of the lake and industrial areas to the east of the lake.

Rainfall in natural areas, and even in agricultural areas, has the ability to infiltrate the porous soil. The majority of this water will slowly find it way into the groundwater, where it has a much longer residence time in comparison to surface water. The groundwater will gradually recharge streams and lakes typically through springs. In comparison, the rainfall in urbanized areas come in contact with many impervious surfaces such as rooftops, patios, driveways, roadways and parking lots. The surface water runoff from these impervious surfaces is not absorbed into the porous soil where it becomes part of the groundwater. This surface water runoff flows directly into stormwater sewers, ditches, streams and lakes.

Contaminants from roadways and parking lots can be pickup by this flow and transported into the streams and lakes, negatively affecting the aquatic life in these ecosystems. The additional surface water runoff causes increased flooding and erosion of land surfaces. The eroding soils are then transported from the surface water runoff, into streams and lakes where it adds to the problematic situation of sedimentation.

Stormwater impoundments, sediment traps, wetland areas can lessen the effects of urban developments on water quality and watershed hydrology by increasing storage and providing locations for sediment load removal. Roadways and parking lots can utilize porous pavements to enhance infiltration and decrease stormwater runoff volumes, thus reducing erosion and flooding.

The following discusses land use in the broader overall Center Lake watershed. Recall the overall watershed includes areas outside the limits of the USGS defined watershed of Center Lake. This broader area has been broken into three sub-watersheds referred to here as:

- Center/Pike Lake,
- Tippecanoe River, and
- Walnut Creek

The basis and rationale for the overall and sub-watersheds has been discussed previously. General land use patterns for each are as follows:

Center/Pike Lake Sub-Watershed
Largely composed of cropland and pasture (35.24%), commercial and services (27.17%), residential (16.93%), lakes (14.66%), industrial (3.69%) and deciduous forest land (2.31%).

Tippecanoe River Sub-Watershed
Largely composed of cropland and pasture (80.12%). The remaining area is made up of deciduous forestland (11.19%), transportation, communications, and utilities (3.29%), residential

(1.66%), industrial (1.37%), commercial services (1.36%), strip mines (0.74%), and lakes (0.28%).

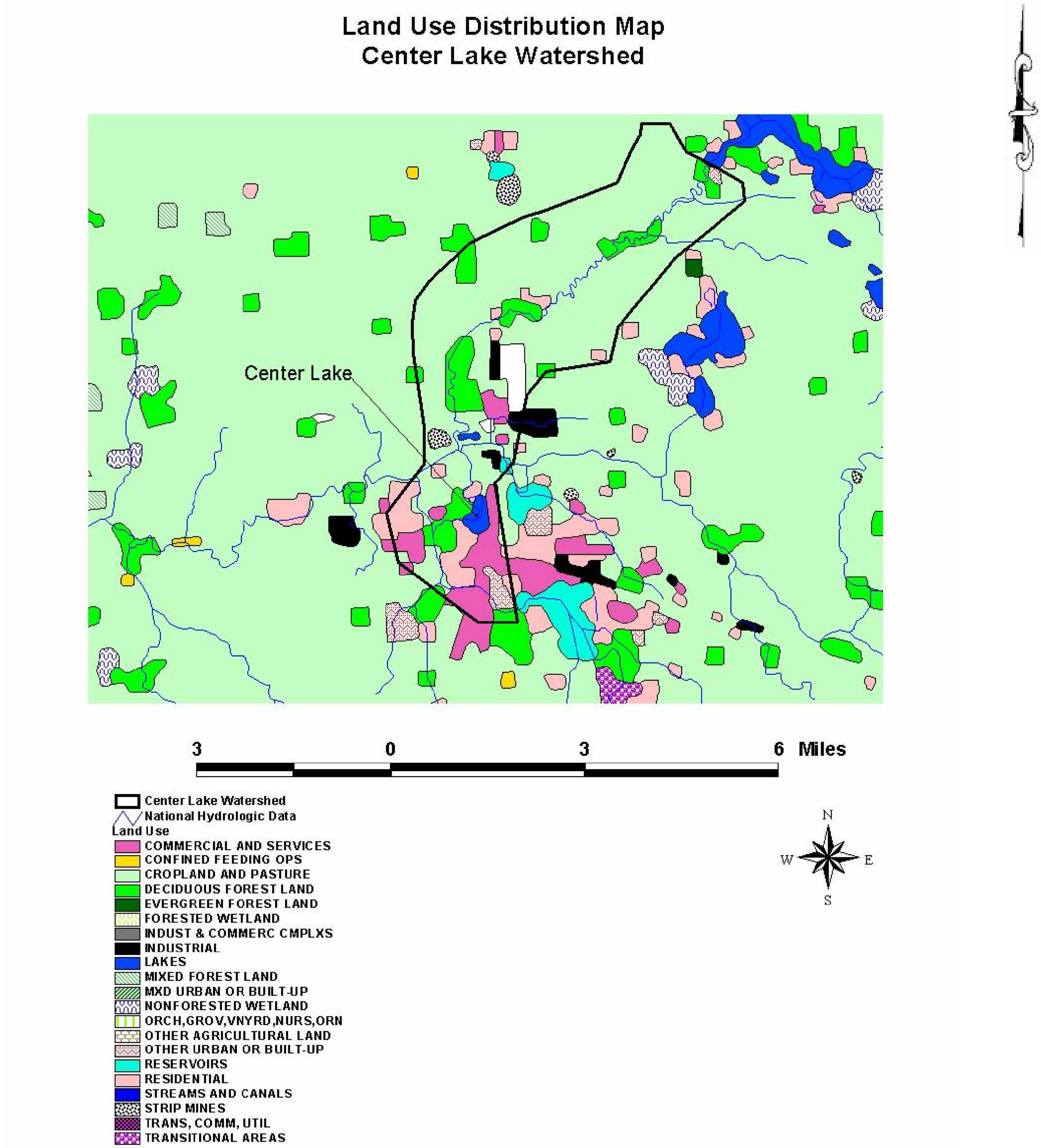
Walnut Creek Sub-Watershed
Has a more urbanizing land use comprised of commercial and services (28.67%), residential (23.95%), cropland and pasture (23.01%), deciduous forestland (16.12%), and other urban built up (8.25%).

A watershed land use description is located on Table 5 for the Direct Tributary Watershed of Center Lake. A map illustrating the land use is shown on Figure 9. The Overall Center Lake Watershed land use patterns are described within Table 6.

Conclusions
The land use in the direct tributary Center Lake watershed is largely residential, commercial and industrial according to aerial photos. However, within the overall watershed to Center Lake, the land is primarily used for agricultural purposes (67.9%).

TABLE 5 – LAND USE IN THE DIRECT TRIBUTARY WATERSHED OF CENTER LAKE

Sub-watershed	Topography	Area (acres)	Percentage
Center Lake/Pike Lake	Deciduous forest land	10.5	2.31%
	Cropland and pasture	312.7	35.24%
	Industrial	32.7	3.69%
	Commercial & Serv.	241.1	27.17%
	Residential	150.3	16.93%
	Lakes	130.1	14.66%
	Total	888	100 %
Tippecanoe River	Deciduous Forestland	824.5	11.19%
	Cropland and Pasture	5903.5	80.12%
	Industrial	101	1.37%
	Strip mines	54.2	0.74%
	Commercial & Serv.	100.2	1.36%
	Trans,comm,util.	242.2	3.29%
	Residential	122	1.66%
	Lakes	20.5	0.28%
	Total	7368	100 %
Walnut Creek	Deciduous Forestland	218.3	16.12%
	Cropland and Pasture	311.8	23.01%
	Commercial & Serv.	388.3	28.67%
	Urban built & others	111.8	8.25%
	Residential	324.4	23.95%
	Total	1355	100%



USEPA Land Data, 1999. Resolution 30m

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	Client: Center Lake Conservation Association	Project No. 02218	Figure: 9	Sheet: 1 Of: 1
		File Name: N/A	Effective Date: 1/08/04	Scale: NTS

TABLE 6 – LAND USE PERCENTAGES FOR THE OVERALL CENTER LAKE WATERSHED

Categories	Area (acres)	Percent of Watershed
Cropland and Pasture	6528	67.9%
Deciduous Forest Land	1060.39	11.03%
Commercial and Services	729.62	7.59%
Residential	597	6.20%
Lakes*	150.1	1.56%
Industrial**	133.6	1.39%
Strip Mines	54.2	1.16%
Transportation, communication, utilities	242.3	2.52%
Other urban and build-up	111.8	1.16%

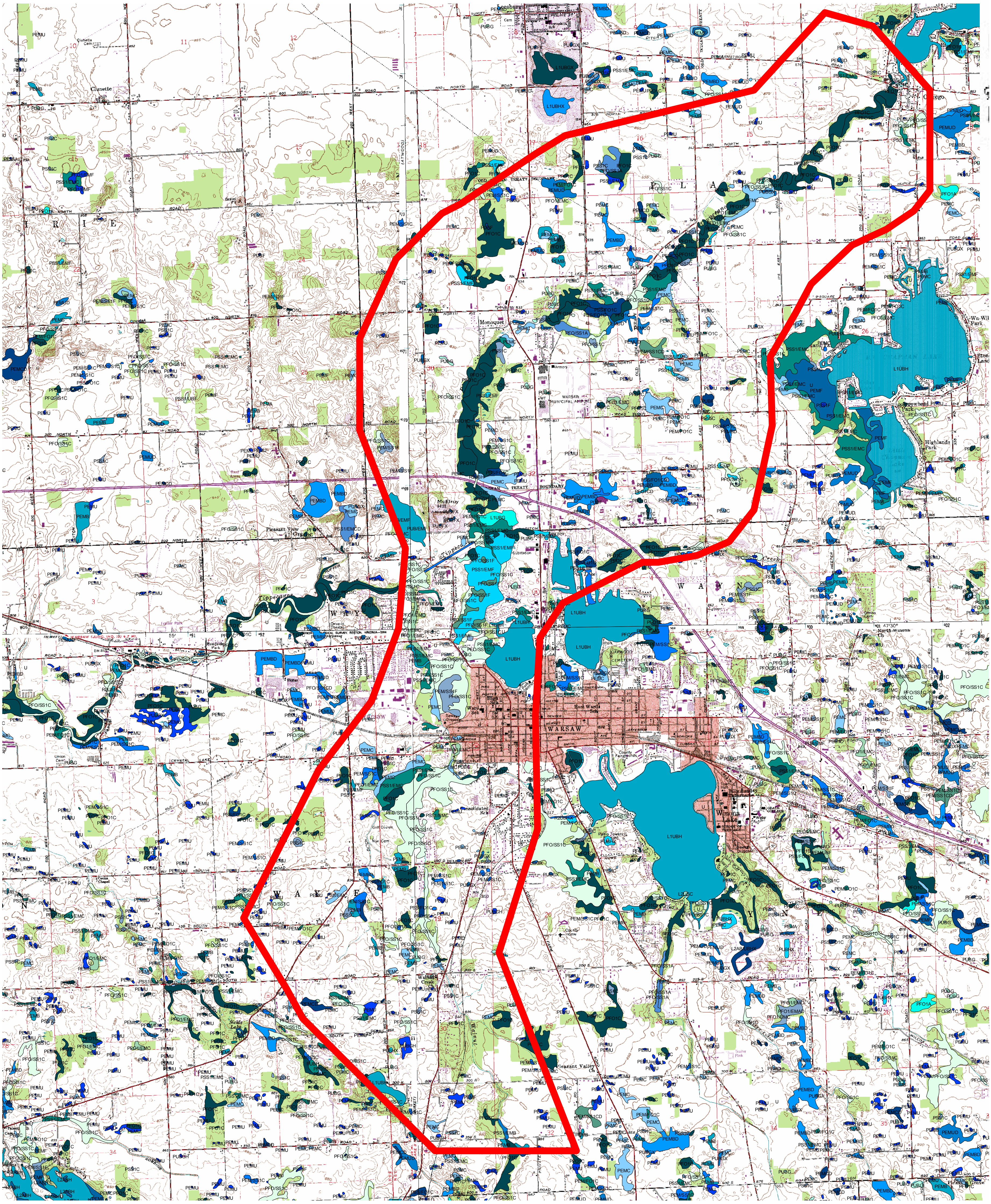
**= No industries in the Walnut Creek sub-watershed
*= No lakes in the Walnut Creek sub-watershed

2.4 Wetlands, Floodplain and Riparian Zones

The overall Center Lake watershed, which consists of 9,611 acres, has approximately 800 acres of wetlands. Forested and nonforested wetlands are shown on Figure 9. The National Wetland Inventory Map is shown on Figure 10. Wetlands provide numerous valuable functions that are necessary for watershed health. Paramount of these functions is the improvement of water quality, which is accomplished by the stabilizing and filtering functions provided by the dense wetland vegetation. The wetland vegetation stabilizes the shoreline by providing protection from the erosive pressures of wave action. An unprotected shoreline can quickly erode from wave action, which results in an increase of sediment and nutrients entering the water. Additionally, the vegetation removes pollutants through the natural filtration that occurs, or by absorption and assimilation. This effective treatment of nutrients and stabilization leads to an increase in overall water quality.

Wetlands can also provide temporary storage of rainwater, thereby protecting downstream areas, because wetland soil have a high amount of pore space and usually have a high content of organic material. This stormwater attenuation provided by wetlands reduces peak flows on rivers, which reduces downstream flooding and erosion. Some wetlands also recharge groundwater, which allows water to seep slowly and replenish an underlying aquifer. This groundwater recharge also is valuable to wildlife during the summer months when precipitation is low.

As a small component of the natural landscape, wetlands contain an unusually large percentage of wildlife and produce more living things per acre than other ecosystems. As a result of this high diversity, wetlands provide enormous recreational opportunities, such as fishing, boating, hiking and bird watching.



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Title: National Wetland Inventory Map		Project: Center Lake	
Client: Center Lake Conservation Association	Project No. 02218	Figure: 10	Sheet: 1 Of: 2
	File Name: N/A	Effective Date: 09/14/04	Scale: NTS

Map Legend:

L1UBG	PEMF	PSS1/EMF
L1UBGX	PEMFD	PSS1/UBF
L1UBH	PEMU	PSS1AD
L1UBHX	PEMUD	PSS1B
L2AB/UBH	PFO/EMC	PSS1C
L2AB/UBHX	PFO/SS1A	PSS1CD
L2ABH	PFO/SS1AD	PSS1F
L2USC	PFO/SS1C	PSS5C
PAB/UBH	PFO/SS1CD	PUB/ABG
PABG	PFO/SS1F	PUB/EMF
PEM/FO1C	PFO1/EMAD	PUB/FO5G
PEM/FO1CD	PFO1/EMC	PUB/SS5G
PEM/FO1F	PFO1/EMF	PUBF
PEM/SS1B	PFO1A	PUBFX
PEM/SS1C	PFO1C	PUBG
PEM/SS1CD	PFO1CD	PUBGH
PEM/SS1F	PFO1F	PUBGX
PEM/UBF	PSS/EMC	PUBH
PEM2C	PSS/FO1C	PUBHH
PEMA	PSS/FO1CD	PUBHX
PEMAD	PSS/FO1F	R2UBH
PEMB	PSS1/EMA	R2UBHX
PEMBD	PSS1/EMB	
PEMC	PSS1/EMC	
PEMCD	PSS1/EMCD	

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Title: National Wetland Inventory Map	Project: Center Lake		
Client: Center Lake Conservation Association	Project No. 02218	Figure: 10	Sheet: 2 Of: 2
	File Name: N/A	Effective Date: 09/13/04	Scale: NTS

2.5 Significant Natural Areas

Adjacent to the channel north of Center Lake and to the northwest of Center Lake is the 25.5-acre Center Lake Wetland Conservation Area, owned by the Indiana Department of Natural Resources Division of Fish and Wildlife. This conservation area has access restrictions as it acts as a wildlife sanctuary area. There is a significant wetland component to this property. The upland features to this property are limited to the spoil that was placed from the dredging of the north channel which connected Center Lake to Lones Ditch. The north shore of Center Lake has a 7.19 acre property that was donated to the Kosciusko County Soil and Water Conservation District that consists of a significant wetland component. The Donna Jean Simpson property on the west shore of Center Lake provides the only other significant natural area along the shore of Center Lake. This is private property and consists of approximately 13.49 acres.

2.6 Threatened and Endangered Species

The U.S. Fish and Wildlife Service (USFWS) was contacted to provide records of any listed threatened or endangered species or natural areas that occur within the Center Lake watershed. Additionally, the Indiana Department of Natural Resources was also contacted to provide any Indiana Natural Heritage Data or related records for any listed threatened or endangered species or natural areas within the watershed. The response letters to these inquiries are provided within Appendix III.

3.0 LAKE BIOASSESSMENT

3.1 Chemical Analysis and Water Quality

This section summarizes the evaluation of Center Lake's water quality. V3 conducted sampling events (August 20, 21 and 22, 2003) in late summer during the peak of stratification (layers of the lake's water possess different temperatures which have different densities and do not mix). As mentioned in Section 1.0, the parameters included during water quality sampling include total phosphorus, total nitrogen ammonia, dissolved oxygen, pH, alkalinity, transparency, turbidity, conductivity, oxidation-reduction potential, and temperature. Laboratory reports on water quality analysis from these sampling events are provided within Appendix IV. Key lake parameters and their relevance to the lake water quality are summarized below:

<u>Phosphorus</u>

Phosphorus is a major cellular component of organisms. Phosphorus can be found in its dissolved and sediment-bound forms. However, in lakes, phosphorus is often locked up in living biota, primarily algae. In the watershed, phosphorus is found in fertilizers and in human and animal wastes. The availability of phosphorus determines the growth and production of algae and makes it the limiting nutrient in lakes. In this study, lake and tributary water samples were analyzed for dissolved and total phosphorus. Dissolved phosphorus is important because it is readily usable by algae. Total phosphorus values are important because concentrations greater than 0.03 mg/L (30μg/L) can cause algal blooms.

Nitrogen

Nitrogen is another major cellular component of organisms. Nitrogen can enter lakes from the air and as inorganic nitrogen and ammonia for use by bacteria, algae and larger plants. The three common forms of nitrogen are:

- Nitrate (NO_3) – nitrate is dissolved nitrogen that is converted to ammonia by algae. It is found in lakes when dissolved oxygen is present.
- Ammonium (NH_4) – Ammonium is dissolved nitrogen that is the preferred form of nitrogen for algae use. Bacteria produce ammonium as they decompose dead plant and animal matter. Ammonium is found where dissolved oxygen is lacking, often in the hypolimnia of eutrophic lakes.
- Organic nitrogen – (*TKN*) Organic nitrogen includes nitrogen found in plants and animal materials. In the analytical procedures, total Kjeldhal nitrogen (*TKN*) is analyzed.

Dissolved Oxygen

Dissolved oxygen is the gaseous form of oxygen and is essential for respiration of aquatic organisms (i.e. fish and plant). Dissolved oxygen enters water by diffusion from the atmosphere and as a byproduct of photosynthesis by algae and plants. Large amounts of dissolved oxygen in the water indicate excessive algae growth. Dissolved oxygen is consumed by respiration of aquatic organisms and during bacterial decomposition of plant and animal matter.

Alkalinity and pH

The pH of a water body reflects the concentration of hydroxide (OH^-) in the water body. A low pH signifies an acidic medium (lethal effects of most acids begin to appear at pH = 4.5) while a high pH signifies an alkaline medium (lethal effects of most alkalis begin to appear at pH = 9.5). Neutral pH is 7. The actual pH of a water body indicates the buffering capacity of the water body. The buffering capacity of the lake is important in determine the lake's ability to maintain life.

Bacteria, Fecal Coliform and E Coli

Escherichia coli, know as *E coli*, is a member of the fecal coliform group of bacteria. When this organism is detected within water samples it is an indication of fecal contamination. *E coli* is an indigenous fecal flora of warm-blooded animals. Contributions of detectable *E coli* colonies may appear within water samples due to the input from human or animal waste. Common sources of animal waste are agricultural feedlots (pigs, cattle, etc…), pet waste (such as dogs) or bird waste (such as Canada geese or seagulls). Rain storm events or snow melts frequently wash waste and the associated *E coli* into surface water systems.

Appendix V provides the historical *E coli* data collected by the Kosciusko County Health Department at Center Lake from 1996 through 2003. The results of these analyses are used by the Kosciusko County Health Department to determine if there is a significant threat to human health from primary contact with bacteria. In such a circumstance, where the colony forming units or cfu's of *E Coli* bacteria in a water sample of 100 mL is equal to or greater than 235 cfu, the public swimming beach at Center Lake is closed until the bacteria levels reach a safe level.

Secchi Disk Transparency, Temperature and Turbidity

Secchi Disk Transparency is the depth at which the contrast between alternating black and white quarters of a disk can be seen in the water by the human eye. It is a measure of the clarity of the water. A high Secchi disk transparency signifies high water clarity. The lake transparency can be affected by two primary factors: algae and suspended particulate matter. An increase in the density of the phytoplankton signifies an increase in the lake turbidity.

The ecological effects of light and temperature on the photosynthesis and growth of algae are inseparable because of the interrelationships in metabolism and light saturation. One commonly observed change in the rate of respiration of planktonic algae is an increase of the rate with increasing temperature. Additionally, the depth at which maximum rates of planktonic algae photosynthesis occur varies with transparency conditions of the water.

Oxidation-Reduction Potential (ORP)

The oxidation-reduction potential (ORP) is proportional to the equivalent free energy change of electrons associated with a given reduction. The potential is large and positive in strongly oxidizing solutions. The oxidation potential has been found to remain fairly high and positive at all depths in a water body as long as the water is not near anoxic conditions (lack of dissolved oxygen) (Wetzel 1975). As the oxygen conditions approach zero and anoxic conditions appear, the ORP decreases dramatically. Within the sediments at the bottom of the lake, reducing conditions prevail and the ORP reaches zero and negative values within a few milliliters of the sediment-water interface.

Conductivity

The conductance of lake water is the reciprocal of its resistance to electrical flow. The resistance of a water solution to electrical current or electron flow is reduced with increasing content of ionized salt. Hence, the purer the water is, i.e. the lower its conductivity.

Table 7 summarizes historical and current chemical characteristics of Center Lake gathered by IDEM, V3 and CLCA.

TABLE 7 – SUMMARY OF HISTORICAL AND CURRENT DATA FOR CENTER LAKE

Parameters	**1991**	**1994**	**1998**	**2003**
Data Source	IDEM	IDEM	IDEM	Present Study
Total Phosphorus (mg/L) Epilimnion	0.044	0.01	0.15	<0.05
Total Phosphorus (mg/L) Hypolimnion	0.02	0.2775	0.037	0.46
NH_3 (mg/L) Epilimnion	0.027	0.018	0.085	<0.1
NH_3 (mg/L) Hypolimnion	0.342	0.322	0.105	2.1
TKN (mg/L) Epilimnion	--	0.552	0.489	<1.0
TKN (mg/L) Hypolimnion	--	1.561	0.502	3.3
Dissolved Oxygen (mg/L) Epilimnion	--	7.9	10	7.65
Dissolved Oxygen (mg/L) Hypolimnion	--	1.8	0.1	0.90
pH Epilimnion	--	8.5	8.5	7.92
pH Hypolimnion	--	7.5	7.5	8.06
Alkalinity Epilimnion	--	136.5	141.85	--
Alkalinity Hypolimnion	--	211	171.9	--
Secchi (m)	1.1	2.2	1.9	1.6
ORP (mV) Epilimnion	--	--	--	45
ORP (mV) Hypolimnion	--	--	--	-128
Temperature (°C) Epilimnion	--	24.5	28.2	27.5
Temperature (°C) hypolimnion	--	10.3	16.8	8.4
Conductivity (mμohms) Epilimnion	--	--	--	576.9
Conductivity (mμohms) Hypolimnion	--	--	--	594.8
Turbidity (NTU) Epilimnion	--	--	--	2.15
Turbidity Hypolimnion (NTU)	--	--	--	54.4
Chlorophyll A - Analysis to be re-sampled in 2005, results and interpretation will be provided in an addendum to this report.				

Results of Center Lake Sampling

The following summarizes the basic water quality conditions and trends based on available historic water quality data and parameters collected during the current study.

- Historic phosphorous indicates that although total phosphorus concentrations fluctuate, they appear to increase with time (0.02 mg/L in 1991 compared to 0.46 mg/L in 2003). Additionally, concentrations observed within the hypolimnion are greater than those observed within the epilimnion. A consistent pattern exists of lower concentrations in the surface waters and higher concentrations in the bottom waters. This suggests that there is phosphorus being released from sediments in the bottom of the lake.

- Historic nitrogen concentrations show a slight decrease (0.552 mg/L in 1994 compared to 0.489 mg/L in 1998). Additionally, we notice consistent higher concentrations of nitrogen in the hypolimnion. Ammonium concentrations also follow the same trend and are higher in the hypolimnion (<0.1 mg/L in the epilimnion versus 2.1 mg/L in the hypolimnion in 2003). Since ammonium is a by-product of bacterial decomposition, this suggests an intense bacterial activity in the bottom of the lake.

- The dissolved oxygen profile of Center Lake shows that oxygen deficiency conditions (anoxic) conditions start at a depth of approximately 3.5 meters. This upper section of the lake is also the section where there is enough light for photosynthesis or algae growth to occur. Below the 5 feet depth, dissolved oxygen concentrations rapidly decline, indicating that bacteria decompose algae as they settle down the water column. Figure 11 shows the dissolved oxygen profile in Center Lake.

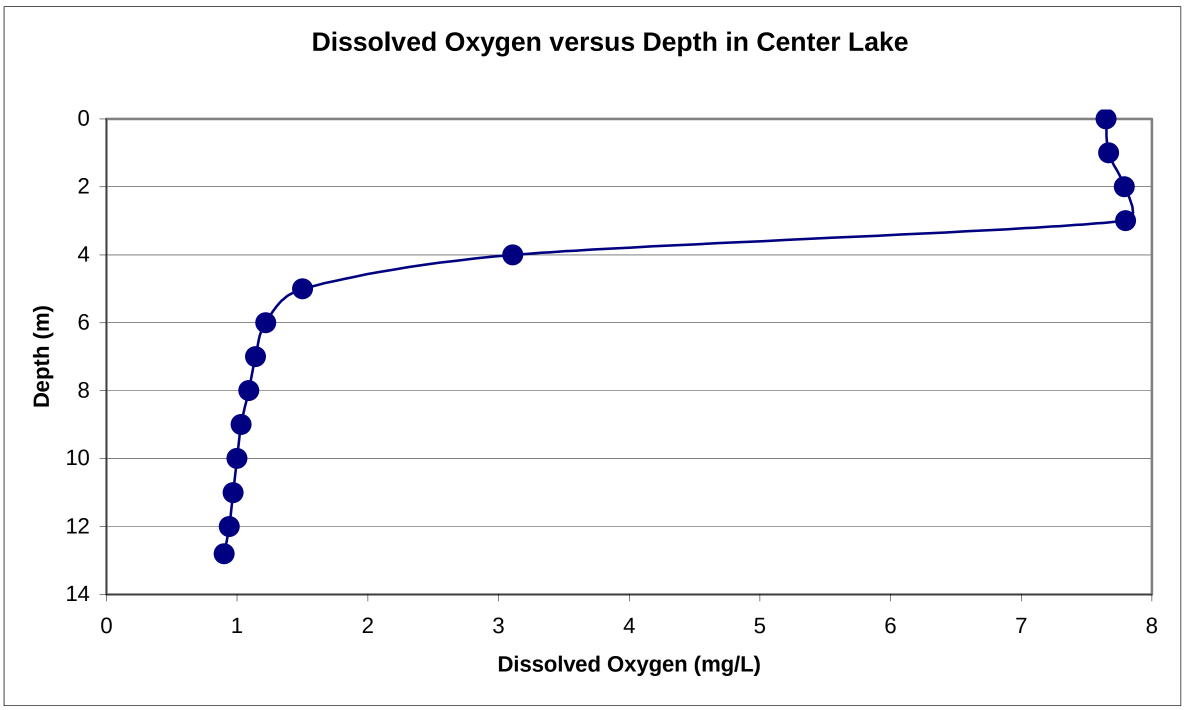


FIGURE 11 – DISSOLVED OXYGEN IN CENTER LAKE

- Historic pH and alkalinity data indicates Center Lake pH values are within the normal range for Indiana. The high alkalinity indicates that the lake is a well-buffered system.

- Historical Secchi disk transparency was variable, as expected. The temperature profile of Center Lake shows epilimnion area ranges from 0 to 3.5 meters the metalimnion ranges from 3.5 to 8 and the hypolimnion from 6 to 12.8 meters.

Figure 12 illustrates the Temperature profile at Center Lake. Turbidity values are higher in the hypolimnion.

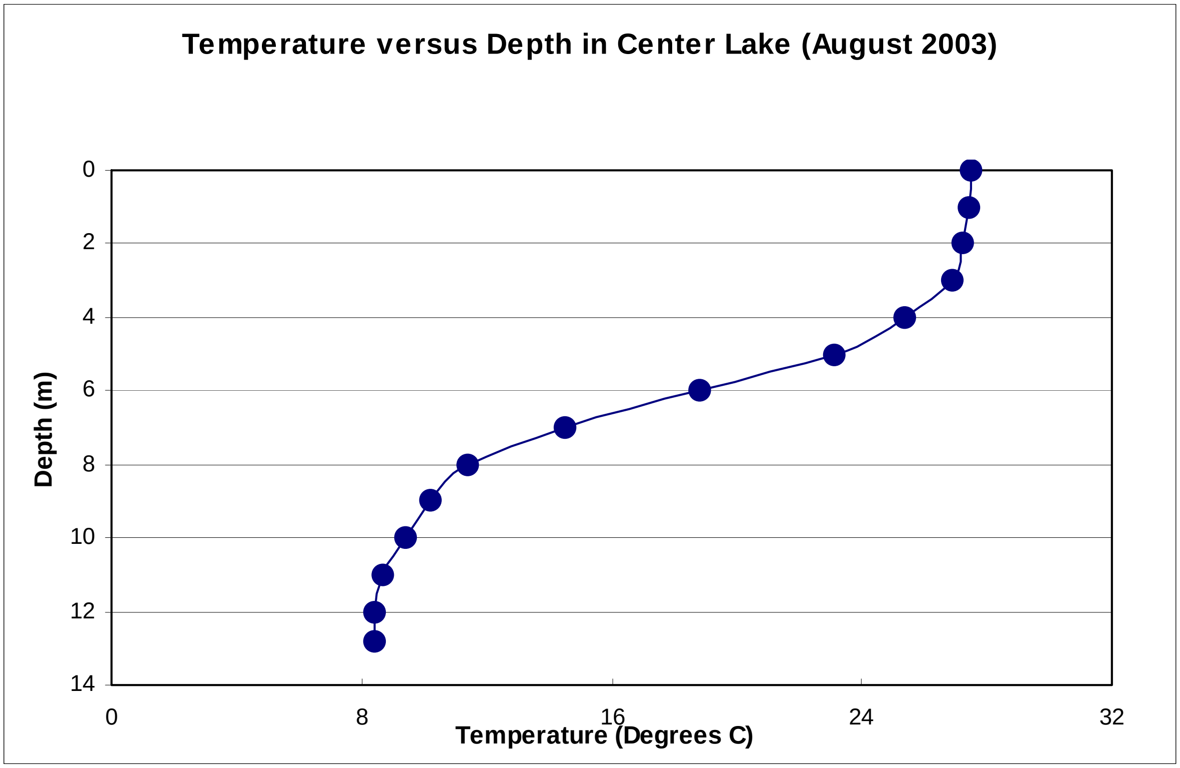


FIGURE 12 – TEMPERATURE PROFILE IN CENTER LAKE

- ORP values obtained in August 2003 suggest reduction conditions in the sediments (negative 128 millivolts). As indicated earlier, the negative value indicate that the ORD data was obtained close to the water-sediment interface.

- The conductivity values obtained on August 2003 indicate a higher conductance in the hypolimnion of the lake. That means that there are more ions in the bottom of the lake.

- Analysis of algae from Center Lake includes sampling activities conducted on September 4, 2003 and August 19, 2004. The species list and biovolume results from 2004 are included in Appendix IV. No toxin producing blue-green algae genera were present in 2003 or 2004. Chlorophyll A was requested but not performed. A subsequent sampling will take place in 2005, and the results will be amended to this report when they become available.

Conclusions of Lake Sampling

Water sample analysis from Center Lake suggests intense bacterial activities at the bottom of the lake. These indications are supported by a consistent pattern of higher concentrations of ammonium and very low dissolved oxygen concentrations in the hypolimnion. Additionally, consistent high concentrations of nutrients (total phosphorus and total nitrogen) in the bottom of the lake suggest that nutrients are released from the sediments at the bottom of the lake. This is common in eutrophic lakes that have decaying plant and algae settling out of the lake, which causes low dissolved oxygen levels (see Figure 9). The condition of low dissolved oxygen levels at the bottom of Center Lake could be improved by reducing the amount of nutrients (nitrogen and phosphorus) that are entering the lake and leading to an increased growth of algae and aquatic plants.

Results of Tributary (Walnut Creek, Tippecanoe River, and Lones Ditch) Sampling
In August 2003 V3 conducted Center Lake tributary sampling events during base flow and storm conditions. Water samples were obtained from the surface of Walnut Creek, Tippecanoe River and Pike Lake (at the Lones Ditch) and were analyzed for nitrogen-Ammonia, nitrogen-Nitrate, nitrogen-nitrite, total nitrogen, dissolved phosphorus, total phosphorus, temperature, fecal coliform, and *E coli*. The results of the tributary sampling are summarized on Tables 8 and 9. Sampling data collected within the parameters of stream discharge, turbidity and conductivity has not been included as the integrity of this data was compromised.

Discussion and Conclusions
The results show that Walnut Creek maintains the highest concentrations of total phosphorus during both base flow and storm flow conditions (2 mg/L and 1.2 mg/L, respectively). These total phosphorus concentrations are higher than the phosphorus concentrations at the surface of Center Lake (<0.05 mg/L). While it is difficult to quantify the actual nutrient mass loading resulting from these inflows (for reasons discussed further in Section 4.0), this indicates minimizing potential inflows from this water body may assist in attenuating nutrient loading impacts to Center Lake. It is also likely that high water (first flush) flows from the Tippecanoe River and Lones Ditch contribute to excessive nutrient loads to Center Lake, although the available data is not necessarily confirming.

TABLE 8 – BASE FLOW SAMPLING AUGUST 20 AND 21, 2003

Parameter	Walnut Creek (08/21/03)	Tippecanoe River (08/21/03)	Lones Ditch (Pike Lake) (08/20/03)
Nitrogen, Ammonia (mg/L)	<0.1	<0.1	<0.1
Nitrogen, Nitrate (mg/L)	7.2	0.2	0.2
Nitrogen, Nitrite (mg/L)	<0.01	<0.01	0.03
Nitrogen, Total Kjeldahl (mg/L)	<1.0	<1.0	1.0
Phosphorus, Dissolved (mg/L)	2.3	<0.05	0.06
Phosphorus, Total (mg/L)	2.0	<0.05	0.09
Fecal Coliform (cfu/100mL)	490	150	45

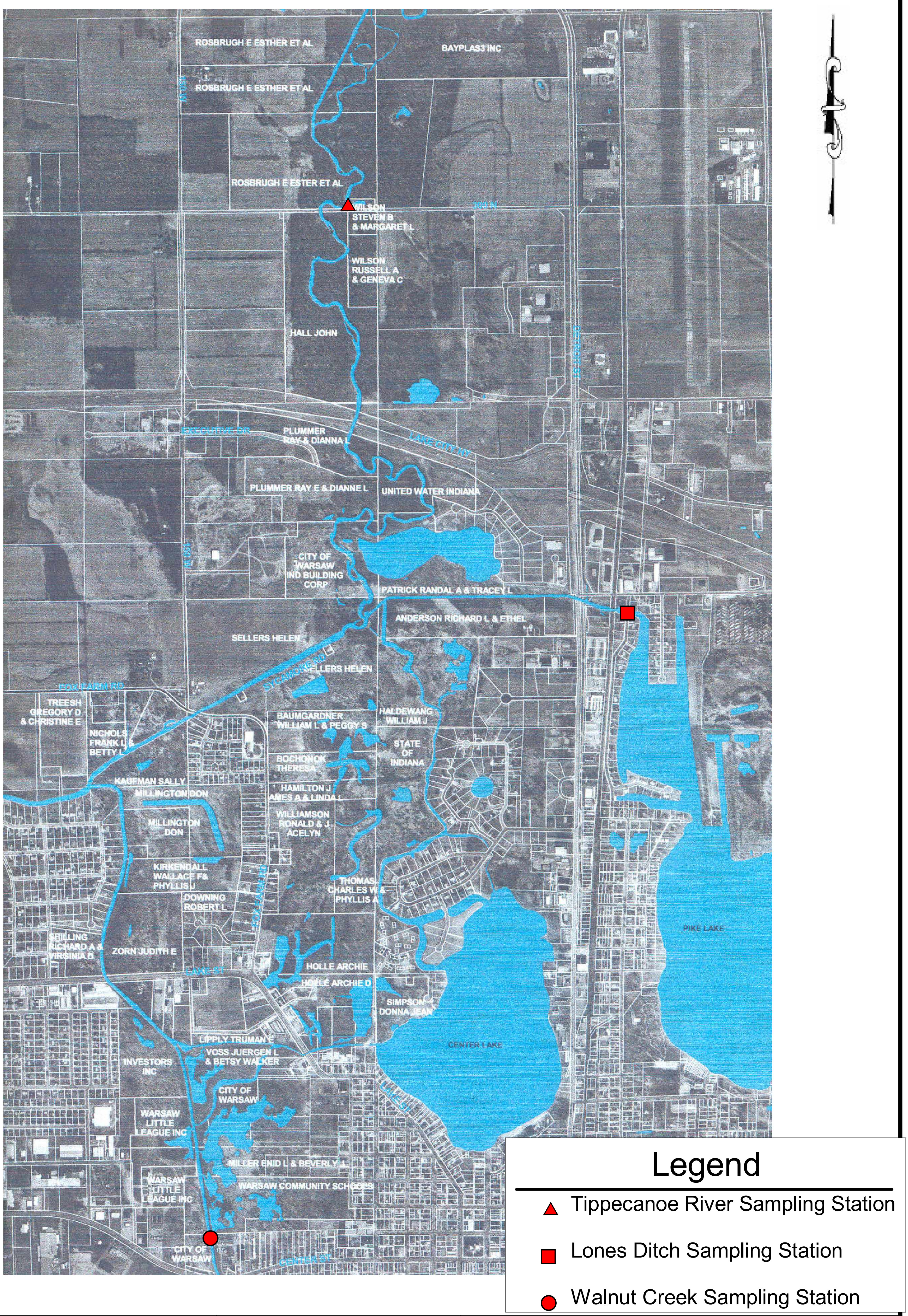
TABLE 9 – STORM FLOW SAMPLING AUGUST 22, 2003

Parameter	Walnut Creek (08/22/03)	Tippecanoe River (08/22/03)	Lones Ditch (Pike Lake) (08/22/03)
Nitrogen, Ammonia (mg/L)	<0.1	<0.1	<0.1
Nitrogen, Nitrate (mg/L)	6.0	0.38	0.32
Nitrogen, Nitrite (mg/L)	0.01	0.01	0.02
Nitrogen, Total Kjeldahl (mg/L)	1.2	0.82	1.4
Phosphorus, Dissolved (mg/L)	1.2	<0.01	<0.01
Phosphorus, Total (mg/L)	1.2	<0.01	<0.01
Fecal Coliform (cfu/100 mL)	4,000	2,400	900
E Coli (cfu/100 mL)	3,450	520	90

3.2 Physical Habitat

Habitat incorporates all aspects of physical and chemical constituents along with the biotic interactions. Habitat includes all of the instream and riparian habitat that influences the structure and function of the aquatic community in a stream. The presence of an altered habitat structure is considered one of the major stressors of aquatic systems. The presence of degraded habitat can sometimes obscure investigations on the effects of toxicity and/or pollution (USEPA 1999).

The purpose for evaluating the physical habitat features of the selected locations within the Center Lake watershed is to quantify the condition and quality of the instream and riparian habitat. The U.S. Environmental Protection Agency (USEPA) rapid and qualitative habitat assessment approach was developed to describe the overall quality of the physical habitat. This was applied to three locations including: the Pike Lake outlet and channel (Lones Ditch), Walnut Creek below the WWTP but above the Center Lake outlet, the Tippecanoe River above its confluence with Walnut Creek. Figure 13 shows the sampling locations. Station photographs and field datasheets are provided in Appendix VI.



V3 CONSULTANTS Engineers • Scientists • Surveyors 7325 Janes Avenue, Suite 100 Woodridge, Illinois 60517 (630) 724-9200	Title: Sampling Station Exhibit	Project: Center Lake	
	Client: Center Lake Conservation Association	Project No. 02218	Figure: 13	Sheet: 1 Of: 1
		File Name: N/A	Effective Date: 1/08/04	Scale: NTS

There are 10 habitat parameters that are evaluated by providing a score of 0 to 20, with the higher the score the better the quality of the habitat. The highest score possible in this assessment is 200. The physical habitat parameters that are degraded will have lower scores, which will lower the overall point total. To ensure consistency in the evaluation procedure, descriptions of the physical parameters and relative criteria are included in the rating form. The ranges for habitat parameter scores are: Optimal = 16 to 20, Suboptimal = 11 to 15, Marginal = 6 to 10, Poor = 0 to 5. The summary of the habitat assessment from the August 2003 survey is provided in Table 10, habitat assessment data sheets are included within Appendix VI.

TABLE 10 – USEPA HABITAT ASSESSMENT RESULTS, AUGUST 20 AND 21, 2003

Habitat Parameter	Tippecanoe River	Lones Ditch	Walnut Creek
Epifaunal Substrate/Available Cover	10	1	4
Pool Substrate Characterization	10	6	12
Pool Variability	16	13	6
Sediment Deposition	13	0	2
Channel Flow Status	16	19	16
Channel Alteration	16	1	11
Channel Sinuosity	15	1	3
Bank Stability	10	18	4
Vegetative Protection	10	0	8
Riparian Vegetative Zone Width	11	0	4
Total Score	127	59	70

The cumulative habitat parameter quality range values would be: Optimal = 151 to 200, Suboptimal = 101 to 150, Marginal = 51 to 100, Poor = 0 to 50. The habitat quality at the Tippecanoe River sampling location is classified as suboptimal, where as the Lones Ditch and Walnut Creek sampling locations both are classified as marginal.

One of the comparisons of these three different waterways as it directly relates to habitat quality is the man-made channelized or ditched component which both Lones Ditch and Walnut Creek posses that the Tippecanoe River does not posses at these specific sampling locations. The quality of habitat within Lones Ditch is encumbered by its lack of vegetative cover which adds to both a physical stabilizing component and an available cover to aquatic life component. The benthic condition is degraded by the accumulation of sediment deposition. The channel alterations in Lones Ditch also contribute to the overall poor quality scores.

Walnut Creek similarly received poor habitat quality scores for vegetative cover, sediment deposition and channel sinuosity. The bank stability value for Walnut Creek also was poor, which contributes to the sediment deposition within the creek. The habitat condition is not as hampered in Walnut Creek as it is in Lones Ditch as the channelization disturbance has had a longer time to begin healing.

Ohio EPA Qualitative Habitat Evaluation Index

In addition to the USEPA habitat assessment, we evaluated the same sampling locations using the Ohio EPA Qualitative Habitat Evaluation Index (QHEI). The maximum is a score that can be obtained is a value of 100. The maximum points possible for each of the habitat parameters are as follows: Substrate = 20, Instream Cover = 20, Channel Morphology = 20, Riparian Zone and Bank Erosion = 10, Pool/Glide Quality = 12, Riffle/Run Quality = 18. Table 11 shows the results of this evaluation, the habitat evaluation data sheets are provided within Appendix VI.

TABLE 11 – QHEI RESULTS, AUGUST 20 AND 21, 2003

Habitat Parameter	Tippecanoe River	Lones Ditch	Walnut Creek
Substrate	15	17	9
Instream Cover	16	3	5
Channel Morphology	16	6	7
Riparian Zone and Bank Erosion	6.5	3	3
Pool/Glide Quality	7	7	3
Riffle/Run Quality	2	0	2
Total Score	62.5	37	29

The total score values are classified within four quality categories: Excellent = 76 to 100, Good = 51 to 75, Fair = 26 to 50, Poor = 0 to 25. The habitat quality at the Tippecanoe River sampling location is classified as good, where as the Lones Ditch and Walnut Creek sampling locations both are classified as fair. Similar to the results of the USEPA habitat assessment, the Ohio EPA QHEI results showed that the habitat at the Tippecanoe River sampling location was a classification better than both the Lones Ditch and Walnut Creek sampling locations.

3.3 Macroinvertebrate Communities

The USEPA's Benthic Macroinvertebrate Protocol for the multihabitat approach utilizes systematic field collection and analysis of benthic macroinvertebrate assemblages. Biological impairment of the benthic community may be indicated by the absence of generally pollution-sensitive macroinvertebrate taxa such as Ephemeroptera, Plecoptera and Tricoptera (EPT); excess dominance by any particular taxon, especially pollution tolerant forms; low overall taxa richness; or unbalances in the community composition.

The multihabitat approach involves the systematic collection of benthic macroinvertebrates from all available instream habitats by kicking the substrate or jabbing with a dip net. A total of 20 jabs or kicks are taken from all major habitat types in the reach resulting in sampling approximately 3.1 m^2 of habitat. The collected organisms are sorted in the laboratory and identified to the lowest practical taxon. The collection procedure provides representative macroinvertebrate fauna from all of the available instream habitats including riffle and run habitat types that provide representatives of scraper and filterer functional feeding groups, and Course Particulate Organic Matter (CPOM) such as detritus, leaves and sticks that provide representatives of the shredder functional feeding group.

Appendix VI contains the field and laboratory data sheets for the benthic macroinvertebrate communities and Table 12 summarizes the findings.

TABLE 12 – BENTHIC MACROINVERTEBRATE RESULTS, AUGUST 20 AND 21, 2003

Parameter	Tippecanoe River	Pike Lake Outlet Channel	Walnut Creek
Total Number of Taxa	24	12	19
Total Number of EPT Taxa	9	3	3
Contribution of Dominant Taxa	19.3%	29.1%	28.0%
Ratio of EPT/Chironomidae	14.0	0.750	0.250
Modified Biotic Index	4.803	7.213	7.012
Ratio of Scraper/Filterer	1.828	0.357	11.0
Ratio of Shredder/Nonshredder	0.080	0.016	0.074
Number of Individuals Evaluated	150	127	161

<u>Discussion Of Benthic Macroinvertebrate Parameters</u>

Richness measures

Total number of distinct taxa is a measure of the diversity within the sample. This value generally increases with increasing water quality, habitat diversity and habitat suitability.

Total number of EPT taxa summarizes the richness of the benthic macroinvertebrate community within the taxa groups that are generally considered pollution sensitive and will generally increase with increasing water quality. This metric is the total number of distinct taxa within the groups Ephemeroptera (mayfly), Plecoptera (stonefly) and Tricoptera (caddisfly).

Composition measures

Percent Contribution of Dominant Taxa uses the abundance of the numerically dominant taxon relative to the total number of organisms as an indication of community balance. This value will decrease as water quality, habitat diversity and habitat suitability improve.

The ratio of EPT (mayflies, stoneflies and caddisflies) and Chironomidae (midges) reflects good biotic condition if the sensitive groups (EPT's) demonstrate a substantial representation. If the Chironomidae have a disproportionately large number of individuals in comparison to the sensitive groups then this situation is indicative of environmental stress.

Tolerance/Intolerance measures

Tolerance/intolerance measures are intended to be representative of relative sensitivity to perturbation. Tolerance is generally non-specific to the type of stressor. However, metrics such as the Hilsenhoff Biotic Index are oriented toward the detection of organic pollution.

The Modified Biotic Index (MBI) was developed to detect organic pollution and is based on the original species level index developed by Hilsenhoff in 1982. Pollution tolerance values range from 0 to 10 and increase as water quality decreases. The lower the MBI, the greater the number of pollution intolerant species. A population of benthic macroinvertebrates that poses a lower MBI value is indicative of higher water quality.

Functional Feeding Group Measures
The ratio of scraper to filtering collector reflects the riffle/run community food base. The relative abundance of scrapers and filtering collectors in the riffle/run habitat is indicative of periphyton community composition, availability of fine particulate organic material and the availability of attachment sites for filtering. Scrapers increase with an increase in diatom abundance and decrease in filamentous algae and aquatic mosses. Filamentous algae and aquatic mosses provide good attachment sites for filtering collectors and the organic enrichment often responsible for filamentous algae growth can also provide fine particulate organic material that is utilized by filtering collectors. Filtering collectors are also sensitive to toxicants bound to fine particles and should be the first group to decrease when exposed to steady sources of such bound toxicants.

Sampling the Coarse Particulate Organic Matter (CPOM) component requires a composite collection of various plant parts such as leaves, needles, twigs, bark or their fragments. Sources for the CPOM sample include leaf packs, shorezones and other depositional areas.

Ratio of Shredder functional feeding group relative to the abundance of all other functional feeding groups allows for the evaluation of potential impairment. Shredders are sensitive to riparian zone impacts and are particularly good indicators of toxic effects when the toxicants involved are readily adsorbed to the CPOM and either affect microbial communities colonizing the CPOM or the shredders directly (USEPA 1989).

<u>Conclusions Regarding Macroinvertebrate Communities</u>
The comparison between the three sampling locations demonstrate that the Tippecanoe River benthic macroinvertebrate community is healthier than that of both Lones Ditch and Walnut Creek. The Tippecanoe River sampling location yielded larger numbers for both of the richness measures. These values become larger as water quality improves. The composition measures both demonstrated that the Tippecanoe River sampling location possessed a healthier community by having a smaller dominant taxa value and having a larger ratio of sensitive groups. The MBI evaluates pollution tolerance of the macroinvertebrate community and having a lower score demonstrates a healthier community.


Photo 1 – Representative species of caddisfly

As water quality increases the diversity of the benthic community should likewise increase which will provide a higher total number of taxa. As the benthic community becomes more diverse, it is anticipated that the number of different species within the mayfly, stonefly and caddisfly order will also increase resulting in a higher total number of EPT taxa. As the individuals within the EPT taxa increase, it is anticipated that the individuals within the chironomidae will not increase within the same proportion, this results in an increase in the ratio of EPT to chironomidae. Photo 1 shows four different species of caddisfly collected during the diagnostic study. These four species have portable cases and are representative of the seven species of caddisfly collected during this study, the other two species do not possess portable cases.

Upon the establishment of a healthier riparian zone the benthic macroinvertebrates such as shredders, which are sensitive to pollutants within the riparian zone, should increase. Reducing the influence of herbicides and pesticides used in the watershed will improvement the riparian zone and should be reflected in the populations of shredders. This will result in a higher value in the ratio of shredders to nonshedders collected. As conditions in habitat, water quality and the surrounding riparian zone improve, the percent contribution of dominant taxa will decrease. As pollutants are diminished the presence of pollution intolerant species will become more numerous within the sampling stations, this will result in a lower Modified Biotic Index value.

The data that was gathered on habitat and benthic macroinvertebrates during this diagnostic study can provide the baseline information for comparisons to any watershed improvement measures that may be implemented in the future.

3.4 Fish Communities

The Indiana Department of Natural Resources (IDNR) has conducted fisheries surveys on Center Lake during 2001, 1997, 1984, 1976 and 1970. The results of the 2001 fisheries survey demonstrated that the Center Lake fishery is healthy. The fish population is dominated by desirable game fish species with a good number of large, "keeper-sized" fish. The 2001 survey collected 2,834 fish that represented 20 different species and one hybrid. Eighty-three percent of these fish are considered game species commonly sought by anglers. These species accounted for 50% of the total weight of fish collected.

The 2001 survey was concerned with the return of Eurasian water-milfoil, but there is not a detectable negative impact on the fishery. However, the strongest recruitment of largemouth bass, bluegill, redear and yellow perch were from 1996 and 1997. During these years the Eurasian water-milfoil was suppressed due to treatment of the lake with a chemical herbicide during October 1996.

Table 13 lists the fish species that are present in Center Lake, presents their numbers as individuals collected, the length range of each species collected and their weight. Fish were collected by the IDNR in 2001 using three types of standard Indiana fish survey equipment including gill-nets, trap-nets and electrofishing. The two netting methods collect fish that are moving through the area where nets are placed. The electrofishing method collects fish in shallow water areas by stunning them with an electric current from a boat and gathering them with nets. Collected fish are identified, measured and released back into Center Lake. All of the eleven species of fish that were collected by the IDNR in 1970 were present in the 2001 collection effort. There is no published fisheries record of sensitive species being extirpated from Center Lake. However, due to the connection of Center Lake to the Tippecanoe River system, riverine species of fish are able to access Center Lake and may be collected within the lake. These riverine species will not have a viable population within the lake as the habitat would not be conducive to naturally sustained populations of riverine communities, although individuals may endure the lake conditions. Examples of such occurrences of fish in Center Lake include the logperch and the northern hog sucker.

TABLE 13 – FISH SPECIES AND RELATIVE ABUNDANCE OF FISHES COLLECTED BY NUMBER AND WEIGHT, CENTER LAKE, JUNE 11 – 13, 2001.

Common Name	Number	Percent Contribution	Length Range (inches)	Weight (lbs)	Percent Contribution
Bluegill	1,990	70.2	1.9 – 9.3	210.45	26.6
Gizzard shad	294	10.4	6.2 – 16.2	197.92	25.1
Redear sunfish	154	5.4	2.5 – 8.9	32.48	4.1
Yellow perch	109	3.8	4.2 – 9.4	12.34	1.6
Largemouth bass	72	2.5	3.8 – 21.0	69.57	8.8
Black crappie	36	1.3	5.9 – 10.6	9.64	1.2
Warmouth	25	0.9	3.7 – 8.0	3.04	0.4
Spotted gar	25	0.9	15.3 – 30.7	43.30	5.5
Longear sunfish	24	0.8	3.7 – 5.9	1.77	0.2
Brown bullhead	20	0.7	9.8 – 14.3	19.87	2.5
Spotted sucker	14	0.5	9.2 – 28.2	27.99	3.5
Northern pike	11	0.4	24.6 – 35.6	59.60	7.5
Hybrid bluegill	10	0.4	3.4 – 6.8	1.33	0.2
Pumpkinseed	10	0.4	2.7 – 4.9	0.52	0.1
Bowfin	9	0.3	16.0 – 29.6	33.26	4.2
Common carp	9	0.3	15.6 – 29.9	54.51	6.9
Yellow bullhead	7	0.2	9.3 – 12.5	4.96	0.6
Golden shiner	6	0.2	8.1 – 9.1	1.39	0.2
Golden redhorse	4	0.1	12.0 – 15.6	5.65	0.7
Brook silverside	3	0.1	3.7 – 4.2	0.03	0.0
Green sunfish	2	0.1	3.6 – 4.0	0.09	0.0
Total = 20 species +1 hybrid	2,834	100%		789.71	100%

3.5 Aquatic Plant Survey

Introduction

V3 conducted a field investigation at Center Lake on July 17 and 18, 2003, to collect data on the aquatic vegetation. The purpose of the investigation was to evaluate the quality of the lake's vegetative community, which would provide additional information to assist with the overall lake assessment. The type of species present can provide critical information such as water clarity, nutrient loading, and the hydrologic regime, which will be used to determine the corrective measures needed to improve the lake.

Methods

The sampling technique utilized during this vegetative assessment was the Aquatic Vegetation Transect Sampling (Shuler & Hoffman 2002). This technique documents the coverage and abundance of the following vegetation types: emergent; non-rooted floating; rooted floating; and, submersed. This survey method is the Aquatic Vegetation Sampling Tier 2 Protocol, also know as the transect method. The Aquatic Vegetation Sampling Tier 1 Protocol was performed in

2004 by Weed Patrol Inc. of Elkhart, Indiana. The results of that survey were not available for inclusion in this diagnostic study, please see this report of Tier 1 results are desired.

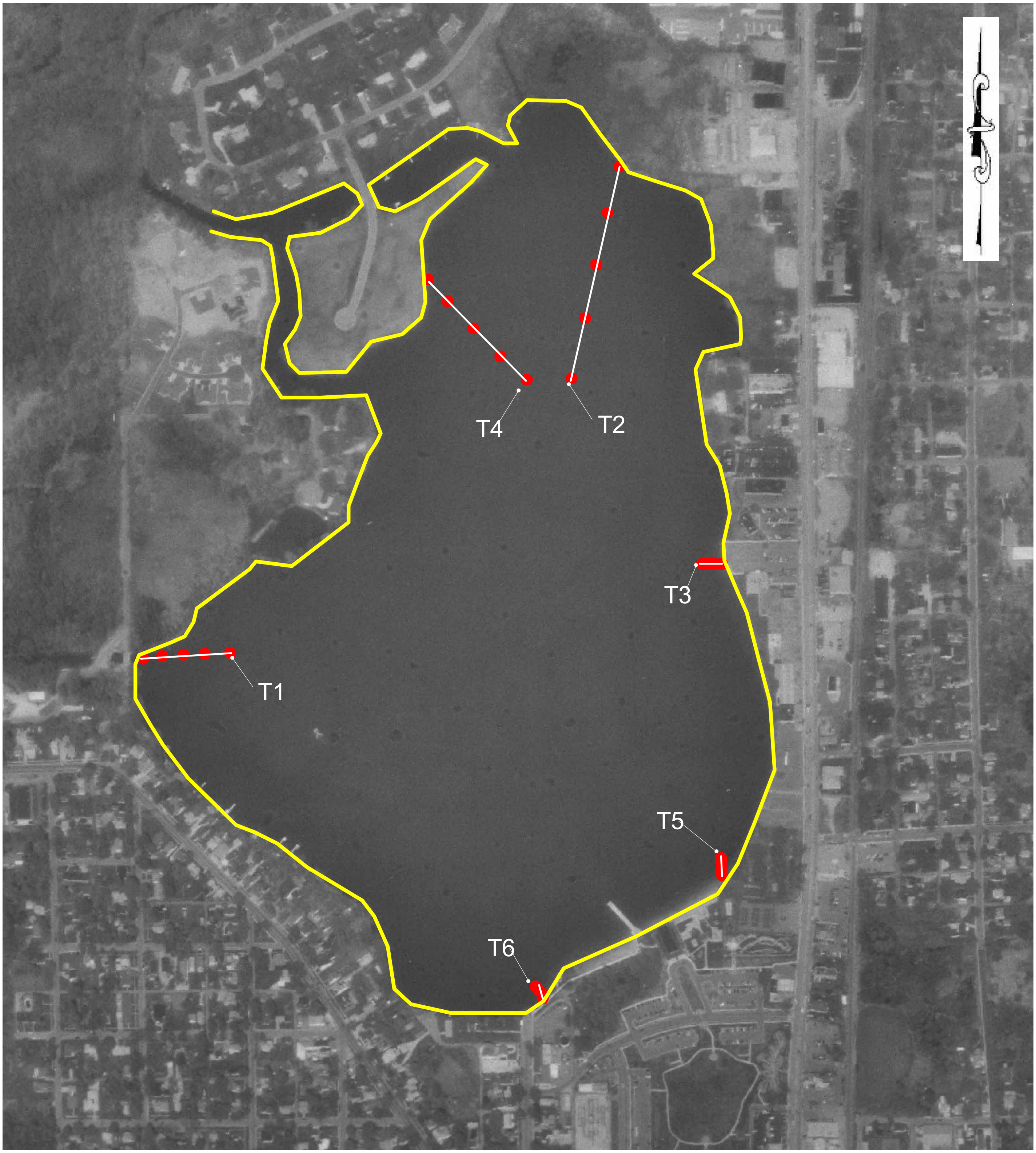
Because the lake was greater than 100 acres but less than 300 acres, six transects were established (see Sampling Transects Exhibit, Figure 14). Each transect had a starting point one meter from shore and ended at the maximum depth of plant growth, encompassing the littoral zone of the lake. Transect locations were established to include all the different lake features to ensure all habitats were identified.

Three to five sampling sites were established along each transect, which depended on the transect length. Sampling site intervals along each transect were based on the distance from the start and end sites, so that intermediate sites were evenly spaced. For example, the nearest sampling site lakeward from the start site was 25% of the distance to the endpoint and the subsequent site was 50% of the distance to the endpoint. Vegetation data was collected from a boat at each of the sampling sites along each transect as discussed below.

Photo 2 – V3 ecologist collects aquatic plants

The sampling technique used both visual estimates and rake grabs to identify the species abundances. The sampling site included an imaginary two-meter arc around the bow and the sides of the boat. The sampling site is separated in half, so that each sampling site contained two separate areas or sub-sample sites. This allowed collection of two sets of data at each site.

Vegetation data collected at each sample site included the following: 1) total canopy coverage of each vegetation type (vegetation types include emergent, non-rooted floating, rooted floating, and submersed); 2) canopy coverage of each species (species abundance ratings): 3) density ratings for submersed vegetation; and 4) density ratings for each submersed species. Other data collected included substrate information and water depth. These data were recorded on the Aquatic Vegetation Transect Site Data Sheets, provided in Appendix VII.



V3 CONSULTANTS Engineers • Scientists • Surveyors 7325 Janes Avenue, Suite 100 Woodridge, Illinois 60517 (630) 724-9200	Title: Sampling Transects Exhibit	Project: Center Lake		
	Client: Center Lake Conservation Association	Project No. 02218	Figure: 14	Sheet: 1 Of: 1
		File Name: N/A	Effective Date: 12-22-03	Scale: 1"=800'

Canopy coverage and species abundance was collected by visual estimates within the two-meter arc. Total canopy coverage was documented on the data sheets in the spaces provided under the "Canopy Abundance at Site", and the species abundance was documented in the "V" column under Species Information. Tables 14 and 15 show the rating systems used to estimate canopy coverage and species abundance.

TABLE 14 – TOTAL VEGETATION CANOPY RATING

Cover (%)	Cover Rating
>61	4
21-60	3
2-20	2
<2	1
None	0

TABLE 15 – SPECIES ABUNDANCE RATING

Cover (%)	Cover Rating
>61	4
21-60	3
2-20	2
<2	1

Submersed vegetation density was collected by extending a double-headed rake outward from the boat into the lake at each sub-sampling site. Thus, two separate submersed density ratings were collected at each sampling site. Once the rake made contact with the lake bottom, it was pulled along the bottom towards the boat, collecting vegetation within the rake teeth. Total plant density was documented on the data sheets in the spaces provided under the "Subsample Site Information", and the density of each species was documented in the "R" columns under Species Information. Density ratings for the vegetation was based on the amount of rake teeth filled, according to the rating system shown in Table 16.

TABLE 16 – RAKE DENSITY RATINGS

Rake Teeth Filled (%)	Density Rating
81-100	5
61-80	4
41-60	3
21-40	2
1-20	1
No plants retrieved	0

Substrate data also were collected and defined according to Table 17.

TABLE 17 – SUBSTRATE TYPES AND CODES

Substrate Type	Code
Silt/Clay	1
Mostly silt with sand	2
Mostly sand with silt	3
Hard clay	4
Gravel/rock	5
Sand	6

<u>Sampling Results</u>

Transect 1

This transect was located on the west side of the lake near the dam, and was approximately three hundred and seventy-five feet in length. Five sampling points were established along this transect. Water depth along this transect ranged from 3.3 to 9.1 feet, with a substrate consisting of mostly silt with sand (Code 2) at sample sites 1-1 thru 1-4, and silt/clay (Code 1) at sample site 1-5.

Plant species observed along this transect included yellow water lily (*Nuphar advena*), duckweed (*Lemna minor*), Eurasian water-milfoil, sago pondweed (*Potamogeton pectinatus*), coontail (*Ceratophyllum demersum*), watermeal (*Wolffia columbiana*), and chara (*Chara vulgaris*).

Sample sites 1-1 and 1-2 had greater than 61% canopy coverage that mainly consisted of yellow water lily, a rooted, floating aquatic species. These sample points were nearest to the shore and had water depths of up to 4.3 feet. Submersed species density ratings were moderate (i.e., density ratings of 2 and 3), which consisted of a fairly even distribution of Eurasian water-milfoil, sago pondweed, coontail and chara.

As sample sites moved lakeward and entered deeper water depths (i.e., 5 to 9 feet) canopy coverage decreased to less than 2% for submersed and nonrooted, floating vegetation. Rooted, floating vegetation was not observed at these depths. Submersed species density ratings were low to moderate (density ratings of 1 and 2), which consisted of Eurasian water-milfoil, sago pondweed, coontail and chara. Eurasian water-milfoil and coontail, however, were the only species observed in the deeper locations of this transect (i.e., sample sites 1-4 and 1-5).

Transect 2

This transect was located at the north side of the lake, at the edge of a natural wetland, and was approximately 897 feet in length. Five sample sites were established along this transect, which traversed water depths ranging from 1.5 to 7.3 feet. The substrate consisted of mostly silt with sand at sample sites 2-1, 2-2, 2-3, and 2-5 and silt/clay at sample site 2-4.

Plant species observed along this transect included narrow-leaved cattail (*Typha angustifolia*), button bush (*Cephalanthus occidentalis*), swamp rose mallow (*Hibiscus palustris*), white water lily (*Nymphaea tubersosa*), duckweed, Eurasian water-milfoil, sago pondweed, and coontail.

Sample site 2-5, which was located one meter from the natural wetland edge, had 21 to 60% canopy coverage that mainly consisted of emergent vegetation. Narrow-leaved cattail, swamp rose mallow and white water lily provided the highest coverage (2 - 20%) at this shallow water depth (1.5 feet). Submersed, non-rooted and rooted floating species had low coverage (less than 2%) at this sample site. As sample sites moved lakeward and entered deeper water depths (i.e., 4 to 7 feet) canopy coverage decreased to less than 2% and consisted of mainly submersed vegetation. Duckweed, a non-rooted floating species, was the only non-submersed species observed.

Submersed species density ratings at sample sites 2-1, 2-2, 2-3, and 2-4, varied widely. The shallower depths, sample sites 2-4 and 2-3, revealed some density ratings of 4 and 5, whereas the deeper sites, 2-1 and 2-2, had density ratings of 2 and 3. Eurasian water-milfoil and coontail consistently had the highest density ratings at these deeper sites.

Transect 3

Transect 3, approximately 100 feet in length, was located on the east side of the lake where the shoreline had a retaining wall. Five sample sites were established along this transect that traversed water depths of between 1 and 8 feet. The substrate closest to the retaining wall (sample site 3-1) was comprised of gravel and rock, while the remainder of the sample sites had a substrate of mostly silt with sand.

Plant species observed along this transect included Illinois pondweed (*Potamogeton illinoensis*), large-leaved pondweed (*Potamogeton amplifolius*), Eurasian water-milfoil, sago pondweed, and coontail.

The sample site nearest the retaining wall treatment did not have any vegetation present. The gravel/rock substrate, which likely resulted from the retaining wall installation, is not conducive to plant growth. The next site, sample site 3-2, had no canopy coverage and only minimal plant density from coontail, a submersed species.

As sample sites moved further lakeward from the retaining wall, vegetation growth improved. Sample sites 3-3, 3-4 and 3-5, had high canopy coverage that consisted of mostly Illinois pondweed (up to 60%). Submersed species densities also were high at these sites, as a result of Eurasian water-milfoil, Illinois pondweed, and coontail.

Transect 4

This transect was located in the north portion of the lake and extended 528 feet in a west-east direction. Five sample points were established along this transect. Water depths along this transect ranged from 1 to 7 feet, with a substrate at shallower depths (4-1, 4-2) consisting of mostly silt with sand, and at deeper depths (4-3, 4-4, 4-5) consisting of silt/clay.

The first sample site (4-1) was located approximately one meter from the shoreline of a small island, which had some natural emergent vegetation around portions of its perimeter. The dominant species observed in the shallow portions of this shoreline sample-site included bristly s edge (*Carex comosa*) and narrow-leaved cattail, whereas white water lily and long-leaved pondweed (*Potamogeton nodosus*) were the dominant species at intermediate depths. Canopy coverage was high, which was mainly due to the high abundance of white water lily (> 61%). Submersed vegetation density was low to moderate (2 – 20%), which consisted of Eurasian water-milfoil, coontail, and sago pondweed.

Emergent and rooted, floating species were not observed at the remaining sample sites, which was likely due to higher water depths (>4 feet). These sample sites did have submersed and non-rooted floating vegetation such as watermeal, duckweed, Eurasian water-milfoil, coontail, and sago pondweed. Canopy coverage of this vegetation was low (<2%), whereas density from rake grabs varied amongst species. At sample sites 4-2, 4-3, and 4-4, water depths between 4 to 5 feet, Eurasian water-milfoil had the highest density (61 to 100 % teeth filled), but was not observed at sample site 4-5, the deepest location along the transect (7 feet). Coontail and sago pondweed were the other submersed species observed at these sample sites including 4-5, but had much lower densities (1 –20% teeth filled).

Transect 5

This transect, which included five sample sites, was located in the southeast portion of the lake. Water depths ranging from 0.7 to 5.7 feet were traversed by this transect as well as a wide variety of substrates, such as sand (5-1), mostly silt with sand (5-2, 5-3) and silt/clay (5-4, 5-5). The sandy soil observed at sample site 5-1 was due to a nearby public beach. Plant species observed along this transect included yellow water lily, duckweed, Eurasian water-milfoil, Illinois pondweed, and coontail.

Sampling sites 5-1 and 5-2, which had water depths of 0.7 to 3.8 feet, revealed low-to moderate (2-20%) canopy cover owed to the rooted floating species white water lily. Plant density of submersed vegetation was relatively high at these sites, which was primarily due to coontail. As sample sites proceeded lakeward and reached water depths above four feet, white water lily was absent. However, Illinois pondweed, another rooted floating species was observed at sample site 5-3 where white water lily was absent. At greater depths, which included sample sites 5-4 and 5-5, coontail and Eurasian water-milfoil and scattered patches of duckweed were observed. Duckweed had low canopy cover at sample site 5-5, and the submersed vegetation densities varied widely. Coontail had a high density (61 to 80 teethed filled) at sample site 5-4, but had low to moderate densities at sample sites 5-3 and 5-5. Eurasian water-milfoil had a low density at sample site 5-3, and was not observed at sample site 5-4 and 5-5.

Transect 6

This transect was located on the south side of the lake adjacent to a boat launch. Due to the small littoral zone, only three sample sites were established. Water depth along this transect ranged from 1 to 5.1 feet, with a substrate consisting of mostly silt with sand at sample sites 6-1 and 6-2, and silt/clay at sample site 6-3.

The first sample site (6-1) was located approximately one meter from the shoreline at a water depth of 0.8 feet. This site had moderate canopy cover (21 to 61%) owing to chairmakers rush (*Scirpus americanus*), a native, emergent species, and white water lily, a rooted floating species. Density of submersed species at this sample site was low, which included Eurasian water-milfoil and coontail. Duckweed and watermeal, two non-rooted floating species, were also present in low abundances.

Sample sites 6-2 and 6-3, which had water depths of between 3 and 5 feet, had similar coverage of white water lily but chairmakers rush was absent. Submersed vegetation density at these sites was high (81 to 100 teeth filled), owing to the high abundance of coontail. Eurasian water-milfoil also was observed at these sites but had a low density.

Vegetation Description

Emergent Vegetation

Where the lake shoreline was undisturbed and contained natural vegetation, mainly along the north and portions of the lake's western side, lush growth of emergent species as well as some scrub/shrub vegetation were present. Natural vegetation was observed along the undisturbed shoreline at the backs of resident's lots, and in a natural wetland at the north side of the lake.

Along the undisturbed shoreline at the back of the resident's properties, emergent species such as narrow-leaved cattail, chairmaker's rush, and bristly sedge were most abundant. These species were observed in water depths of 0.1 to 0.75 feet. No shoreline stabilization problems were observed in these areas, as a result of the natural protection that these species provide.

Scrub/shrub as well as emergent vegetation was located at the north end of the lake where a natural wetland existed (Transect 2, sample site 2-5). Emergent species such as narrow-leaved cattail and swamp rose mallow (*Hibiscus palustris*), and scrub/shrub vegetation that included buttonbush (*Cephalanthus occidentalis*) and red-osier dogwood (*Cornus stolonifera*), dominated this wetland fringe. No shoreline stabilization problems were observed in this area either.

Emergent species were only observed along the undisturbed shoreline, which included Transects 2, 4 and 6. Disturbed shoreline areas of the lake lacked emergent species because these areas did not provide the saturated to shallowly inundated habitat conditions that are required. The undisturbed shoreline, on the other hand, provides an intermittently-flooded condition that allows establishment of emergents along the perimeter. These emergent species can thrive in water depths of up to one-foot and to some degree landward as long as the soil is saturated and mowing is suppressed.

Purple loosestrife, an exotic emergent species, was observed in portions of the undisturbed shoreline. This species thrives in the flooded condition, and can expand at an extremely high rate and thereby displaces native species. Purple loosestrife control is an essential activity necessary to maintain a healthy and diverse shoreline plant community.

Rooted, Floating Vegetation

White water lily and yellow water lily, two rooted floating aquatic species, also had high abundances along the undisturbed shoreline. However, these two species were present in the deeper portions along the shoreline at depths between 0.5 to 4.0 feet. These plants can reduce shoreline erosion by minimizing wave action and also enhances aesthetics due to its round leaf and large floral display.

In addition to the undisturbed shoreline areas of the lake, white and yellow water lilies were also present at several other locations up to 4.0-foot water depths. The only transect that lacked these species was Transect 3, which had a substrate of gravel and rock at shallow water depths. This substrate was not conducive to plant establishment, as coontail was the only species observed.

White and yellow water lilies usually had moderate to high canopy coverage (i.e., 21-60%, and >61%). These species were present in the shallow and intermediate water depths of the littoral zone (i.e., 0.5 to 4 feet) and coverage normally reduced as water depth increased.

Pondweeds were the other rooted, floating aquatic plants observed in the lake, which included sago pondweed, Illinois pondweed, long-leaved pondweed, and large-leaved pondweed. Pondweeds provide habitat for macroinvertabrates, which are an important food source of fish, and can breakdown many pollutants, thereby cleaning water.

Sago pondweed was the most frequently observed pondweed species in the lake. It was observed at four of the six transects (T1, T2, T3, T4) and occurred from shallow to deep water such that it encompassed much of the littoral zone. Sago pondweed did not form large stands, so coverage and density ratings were low. Instead, it was present as solitary individuals scattered throughout much of the littoral zone. Sago pondweed is one of the most common aquatic plants in lakes, and normally indicates a calcareous condition.

Illinois pondweed was observed primarily in the southeastern portion of the lake, along Transects 3, 5 and 6. Its growth habit was distinctly different from sago pondweed, in that it was present in large colonies. As such, moderate to high canopy and density ratings (i.e., 21-60%, and >61%) were noted along the transects. The highest ratings were observed in the deeper portions along Transect 3 near the retaining wall.

Additionally, Illinois pondweed was observed in the southeastern portion of the lake, whereas sago pondweed was observed in the north and western portions of the lake. This establishment disparity is interesting, although the reason is unknown. Except for the differences in slope (i.e., north and west is shallower than the southeast), the habitat appeared to be the same.

The remaining pondweeds observed in the lake, large-leaved pondweed and long-leaved pondweed, were only observed along one transect.

Non-rooted, Floating Vegetation
Watermeal and small duckweed, two non-rooted floating species, were observed in small numbers scattered throughout the lake at various locations. These species tend to colonize quiet waters, such as backwater areas and stagnant channels, and can form dense, thick mats if conditions are suitable. These species were not abundant in the lake and their presence was likely due to wave action, which carried them into the lake from the north channel.

Submersed Vegetation
Coontail, Eurasian water-milfoil, and chara were the submersed species observed on the transects. Chara, an erect algae, was found in very small abundances at only a few transects, whereas coontail and Eurasian water-milfoil were virtually ubiquitous.

Eurasian water-milfoil and coontail were found throughout the entire littoral zone, from depths of 0.5 to 7 feet, and the densities varied widely. In some areas, such as Transects 2 and 4, both species had high densities (i.e., 81 to 100 rake teeth filled). On average, density ratings were moderate (21 - 40 rake teeth filled). There was no apparent pattern to the distribution of these species, except that they were present throughout the entire littoral zone at variable densities and, in some cases, they were the only species present at the deepest locations.

Coontail is a native species whereas Eurasian water-milfoil is an exotic. These two species reproduce by fragmentation, so their high abundances is not surprising. These species have formed large, dense mats in portions of the lake, which is likely interfering with recreational activities such as fishing and boating. Control of these species is usually necessary in order to maintain the recreational aspects of the lake.

Conclusions & Recommendations

Lake Vegetation Summary

Based on the aquatic plant survey, the lake supports both desirable and undesirable plant species. The undisturbed shoreline areas contain desirable emergent and scrub/shrub vegetation that provides bank stabilization and water quality enhancement functions. These species are located along the undisturbed shoreline areas at the back of the resident's lots, and at the edge of a wetland at the north end of the lake. Purple loosestrife, a nonnative species, is also present along portions of the shoreline. This species should be controlled, as it can displace the desirable plants.

Pockets of white and yellow water lilies are scattered at intermediate depths along the lake perimeter. These rooted, floating aquatic species provide water quality benefits and have large, colorful flowers that beautify the lake. Other rooted, floating aquatic vegetation included numerous pondweed species, which were located throughout the littoral zone. One species in particular, sago pondweed, was present in the deepest portions of the zone, in water depths up to 7 feet. Illinois pondweed was found in dense colonies mainly in the southeastern portion of the lake. All of these rooted, floating aquatic species are native, desirable plants and were not observed in large enough numbers to warrant control.

Watermeal and small duckweed, two non-rooted floating species, were observed in small numbers scattered throughout the lake at various locations. These species were not abundant in the lake and their presence was likely due to wave action, which carried them into the lake from the north channel. Chara, an erect algae, was found in very small abundances at only a few transects.

Submersed vegetation was located throughout the entire littoral zone and consisted of two species - coontail and Eurasian water-milfoil. Coontail is native and Eurasian water-milfoil is not. These species were observed in shallow portions near the shoreline mixed with the emergent and floating species, and up to approximately 7-foot depths where they were the only aquatic plants observed. These species were observed at a varying degree of densities that ranged from less than 2% to almost 100%, where dense mats were formed. Eurasian water-milfoil should be controlled, as well as coontail to a lesser degree.

Purple Loosestrife Control

Control of this exotic species is essential in the maintenance of a healthy emergent community. Control can be accomplished by using chemical, mechanical, or biological activities, or a combination of each. Biological control is not recommended at Center Lake, because the purple loosestrife density present is not high enough for this to be successful. A combination of mechanical and chemical control efforts is recommended, which is discussed below.

Mechanical activities consist of removing and disposing the purple loosestrife flowers to prevent additional seed introduction. This is best accomplished when the plants are in full bloom so they can be seen, but before the onset of seeds (June/early July). At this time, the entire flower heads should be cut and bagged for off-site disposal. Removed flowers should not be disposed near any water body as seeds can still germinate following flower removal. Because each plant can produce approximately 2,000,000 viable seeds, removing the flowers to prevent seed dispersal is extremely important. Following flower removal, the remaining portion of each plant should be treated with herbicide. Glyphosate is the most commonly used chemical for killing purple loosestrife. The Glyphosate formula designed for use over water should be used at Center Lake. For best results, the entire foliage of the purple loosestrife plant should be sprayed with the herbicide and two-applications may be needed. The second application should occur two to three weeks after the first to allow brown-out from the first chemical treatment. Because Glyphosate is non-selective, other plants will be harmed if contact with the herbicide occurs. However, a trained applicator with purple loosestrife control experience should be able to avoid most desirable plants. As such, to minimize detrimental affects to desirable species, herbicide applications should be conducted by a trained and licensed applicator. Annual mechanical and chemical efforts will likely be needed to achieve long-term control.

Eurasian Water-Milfoil Control

Eurasian water-milfoil is an exotic species that can form dense mats throughout a lake's entire littoral zone. The dense mats exclude establishment of other aquatic vegetation, reduces the quality of wildlife habitat, and negatively affects recreation. This species grows best in nutrient-rich sediments and its infestations are highest in eutrophic lakes that are high in nitrogen and phosphorous. Eurasian water-milfoil does not die off over the winter and is capable of extremely aggressive growth at the beginning of the growing season, which provides a competitive advantage over native species.

Unlike purple loosestrife, Eurasian water-milfoil reproduces vegetatively, so it does not rely solely upon seed for reproduction. Eurasian water-milfoil can reproduce from plant fragments that can be dispersed over long distances via boats, motors, trailers and even bait buckets. Due to this type of reproduction, Eurasian water-milfoil can dominate an area in a very short time.

The Midwest Aquatic Plant Management Society states that mechanical harvesting is not recommended for control of Eurasian water-milfoil for two reasons:

- The potential for plant fragmentation by mechanical harvesters can serve to spread Eurasian water-milfoil beyond the management areas and intensify problems throughout an infested lake.
- Eurasian water-milfoil will usually dominate the re-growth community and gain further advantages over native species because of its faster relative growth rate.

Similar to purple loosestrife, control of Eurasian water-milfoil can be accomplished by using chemical, mechanical, or biological activities, or a combination of each. Of the three, mechanical harvesting provides the only method in which bio-mass of vegetation, containing nitrogen and phosphorus, is being removed from the system. However, reducing the amount of nutrients entering the lake will ultimately provide long-term control by eliminating its desired environment.

Chemical treatment in the form of herbicide applications are not the preferred control method. Contact with desirable native aquatic plants during the chemical application is unavoidable. Desirable plants as well as some fish may be killed or harmed from chemical treatments. Biological and mechanical activities provide the most effective control of this species, while minimizing detrimental affects to other lake inhabitants. All three of these control activities (chemical, biological and mechanical) have been used at Center Lake. A combination of these three methods of controlling Eurasian water-milfoil may provide the best results.

If chemical treatment is desired, Sonar aquatic herbicide at a low concentration can be effective for controlling Eurasian water-milfoil. In October 1996, SePro Corporation, in cooperation with the City of Warsaw, the Indiana-American Water Company Inc, the CLCA, IDNR, Department of Health and IDEM treated Center Lake with Sonar at a concentration of 12 parts per billion (ppb). The results were effective in reducing Eurasian water-milfoil to a few scattered plants by ice out and native plants were reestablished by late spring (IDNR, 2001). Additionally, Fluridone and Triclopyr have been shown to be safe and effective at low applications rates and are both selective for Eurasian water-milfoil (IDNR, 2004b).

Mechanical control using a harvester, which is owned by the CLCA (Photo 3), has been employed at Center Lake to open boating lanes. The harvester has also been used to control Eurasian water-milfoil and coontail, to a lesser degree. The harvester removes the plants from the water, which lessens water quality problems resulting from the decay of cut plants left in the water. The harvester cuts the vegetation while moving in the water, removes the cut plant material with a conveyor system and can dispose the plant material at an offshore location. The advantages of this control method are:

Photo 3 – CLCA's Weed Harvester

- Immediate plant control is gained;
- Detrimental affects to desirable plants can be reduced from selecting only the densest areas of infestation;
- Oxygen remains in the water when the decomposing plant material is removed from the waterbody; and,
- Water is immediately available, unlike water-use restrictions associated with some herbicidal controls.

The disadvantages of this type of method are:

- Native plants are removed, which reduces the competition and leads to increased Eurasian water-milfoil colonization;
- Wildlife also is removed and/or destroyed;
- Repeated harvesting in one season may be needed;
- Eurasian water-milfoil plant fragments are created, which can promote expansion of this species;

- High cost to operate and maintain; and,
- Plant material disposal issues.

Although there are several disadvantages associated with harvesting Eurasian water-milfoil, the control achieved overrides the negative affects as long as selective harvesting occurs so that disturbance to desirable vegetation and/or wildlife concentrated areas are minimized.

In addition, to maximize the results from the harvesting, an alternative way to dispose of the plant material should be considered. Currently, the removed plant material is being disposed off on the shoreline. These disposal "piles" not only cause disturbance to important shoreline stabilizing vegetation, but also can easily reenter the water column following a rain event or a period of high water elevation, releasing the nutrients back into the water. Because offsite disposal costs are likely high and there is currently little economic use for harvested aquatic plants, the only cost-effective option may be to consider another on-site disposal area that is not along the shoreline. An area that will allow for periodic burning of the plant material should also be considered, which will assist with long-term storage issues.

Biological control also has been used at Center Lake to control Eurasian water-milfoil. Release of *Euhrychiopsis lecontei*, an herbivorous weevil native to North America. An initial release occurred during July of 2000 where 12,000 eggs and larvae contained in stems of Eurasian water-milfoil were attached to plants in Center Lake that had stems of a similar width. Subsequent releases occurred during June 2001 where 5,000 eggs and larvae were released and during July 2003 where 15,000 eggs and larvae were released. All weevil releases were conducted by EnviroScience Inc. Many advantages are associated with biological control, which are provided below:

- The weevil is selective for Eurasian water-milfoil, so detrimental affects to other species is eliminated;
- Little disturbance to the plants occur during release, so the unintentional spread through fragmentation is minimized;
- Maintenance is low;
  Long-term effectiveness is high, so repeated control efforts are unnecessary.

Photo 4 – Stems containing weevils

Photo 5 – Divers releasing weevils

Weevil eggs and larvae arrive at Center Lake contained within Eurasian water-milfoil stems (Photo 4). Divers attach the stems containing weevil eggs and larvae to plants within a dense bed of Eurasian water-milfoil (Photo 5).

A disadvantage in using biological control is that reductions in the population of Eurasian water-milfoil occur over the course of several years. Thus, the immediate response that results from mechanical methods does not occur. Another disadvantage to biological control is that lakes with an abundant sunfish population, such as Center Lake, will provide for predation of the weevil by the sunfish and limit the effectiveness of weevils on controlling Eurasian water-milfoil. However, to achieve long-term effective control of Eurasian water-milfoil with no appreciable impacts to other species in the lake, biological control provides the best alternative.

A combination of mechanical, biological and chemical control activities should continue at the lake as a means of controlling Eurasian water-milfoil.

Shoreline Vegetation Improvements.
In addition to exotic weed control efforts, installation of desirable plants should be conducted. The objectives of the plant installations include:

- Stabilize shoreline areas to reduce sedimentation;
- Filter nutrients from adjacent residences to reduce nitrogen and phosphorus loading;
- Provide competition to reduce the re-establishment of purple loosestrife and Eurasian water-milfoil; and,
- Improve aesthetics.

Species such as chairmakers rush (*Scirpus punjens*), swamp rose mallow, bristly sedge, buttonbush and red osier dogwood could be installed along the shallow portions of the shoreline. At intermediate depths (i.e., 0.5 to 3 feet) installation of white and yellow water lilies could be conducted.

Increasing the width of the naturally vegetated buffer or “vegetated filter strip” around the lake by allowing it to expand landward would also have a positive impact on water quality. The vegetated strip will expand landward by simply adjusting mowing habitats. Basically, suppress mowing where the natural vegetation is desired. Supplemental planting in these areas could also occur to improve aesthetics and functions of the filter strip.

3.6 Plankton Analysis

Plankton samples were collected on September 4, 2003 and were sent to Purdue University for species identification and abundance counts. Water samples were collected within the littoral zone at various locations of Center Lake to characterize the plankton community. Samples were collected in duplicate, with one unpreserved set (to allow for better identification) and one set preserved with Lugol’s Solution (to allow for accurate counts). There were none of the toxin producing blue-green genera such as *Cylindrospermopsis* collected in these samples. The correspondence of these results are contained in Appendix IV, with the laboratory data results.

The information provided from these results is insufficient to assist with the calculation of the IDEM Trophic State Index (TSI). Historical data collected by IDEM was used in the discussion related to eutrophication and TSI in Section 8 of this report.

On August 19, 2004, one water column plankton sample was collected vertically through the area of light penetration (approximately 35 feet) over the deepest part of the lake (approximately 42 feet). This sample was sent to Phyco Tech, Inc. in St. Joseph, Michigan and was to be analyzed for Chlorophyll A, list of species and biovolumes.

However, no Chlorophyll A analysis was performed. Subsequent sampling will be performed during 2005 and the results will be amended to this report. Laboratory results of the species identification and biovolumes from the 2004 sample is contained in Appendix IV. Table 18 lists the species of algae and their biovolumes.

TABLE 18 – ALGAE SPECIES AND TOTAL BIOVOLUME, CENTER LAKE, AUGUST 19, 2004.

Taxonomic Division	Genus	Species	Total Biovolume (µm^3/ml)
Bacillariophyta	*Aulacoseira*	*granulata*	3,435
	Aulacoseira	*ambigua*	4,649
	Cyclotella	*sp.1*	36
Chlorophyta	*Chlorococcaceae*	*spp*	38
	Chlamydomonas	*spp*	64
	Chlorogonium	*spp*	6
	Mougeotia	*spp*	2,147
	Oocystis	*parva*	4
	Pediastrum	*simplex*	4,082
	Scenedesmus	*spp*	2
	Schroederia	*judayi*	16
Chrysophyta	*Dinobryon*	*spp*	322
Cryptophyta	*Rhodomonas*	*minuta*	4
Cyanophyta	*Anabaena*	*planctonica*	6,566
	Aphanizomenon	*flos-aquae*	439
	Aphanocapsa	*delicatissima*	20
	Aphanothece	*nidulans*	3
	Coelosphaerium	*naegelianum*	286
	Lyngbya	*limnetica*	20
	Merismopedia	*tenuissima*	1
	Merismopedia	*warmingiana*	1
	Microcystis	*flos-aquqe*	249
	Oscillatoria	*agardhii*	1,324
	Oscillatoria	*amphibia*	101
	Synechocystis	*spp*	77
Pyrrhophyta	*Ceratium*	*hirundinella*	4,000
	Peridinium	*umbonatum*	6

ADDENDUM:

3.6 Plankton Analysis

On August 16, 2005, one water column plankton sample was collected vertically through the area of light penetration (approximately 35 feet) over the deepest part of the lake (approximately 42 feet). This sample was sent to Phyco Tech, Inc. in St. Joseph, Michigan and was analyzed for a list of species and Chlorophyll A.

Laboratory results of the species identification from the 2005 sample are contained in Appendix IV. Table 18A is a revision of Table 18. This table contains data that compares the species of algae found in the 2004 and 2005 samples.

The toxin producing blue-green genera called *Cylindrospermopsis raciborskii* was collected in the 2005 sample. This is the first instance of blue-green algae being recorded in Center Lake. *Cylindrospermopsis* was first discovered in Indiana during 2001. *Cylindrospermopsis* produces oxygen by photosynthesis and can fix nitrogen from the air and so can live without relying on nitrogen sources in the water. Hot, dry conditions are ideal for growing blue-green algae. Preventing or reducing growth of *Cylindrospermopsis* can be achieved by reducing nutrient runoff into waterways.

Effects this species can have on humans include eye or ear irritations, stomach or head aches, diarrhea, cough, skin irritations, allergic reactions, gastrointestinal symptoms and respiratory problems. Those who may be more susceptible to these effects include children, older people and individuals with sensitive immune systems. Pets and livestock may experience negative health effects since they are more likely to consume larger quantities of lake water.

Blue-green algaes have been reported in high densities in surrounding states and have caused numerous public health advisories and lake closures, as well as dog deaths. However, a study was conducted that found high densities of *Cylindrospermopsis* but very little toxin production. Scientists from IDNR, IDEM, Indiana State Department of Health, U.S. EPA and other organizations are currently addressing issues related to blue-green algae toxins, including the impacts of *Cylindrospermopsis*. If someone suspects they have become sick from exposure to toxins from blue-green algae, they should contact local health officials.

TABLE 18A – ALGAE SPECIES PRESENCE AT CENTER LAKE IN 2004 & 2005.

Taxonomic Division	Genus	Species	Present on 8/19/04	Present on 8/16/05
Bacillariophyta	*Aulacoseira*	*ambigua*	X	X
	Aulacoseira	*granulata*	X	X
	Cocconeis	*placentula*		
	Cyclotella	*ocellata*		X
	Cyclotella	sp. 1	X	
	Rhizosolenia	*longiseta*		X
	Synedra	*tenera*		X
	Synedra	*ulna*		X
Chlorophyta	*Ankistrodesmus*	*convolutus*		X
	Ankistrodesmus	*falcatus*		X
	Chlamydomonas	spp	X	X
	Chlorococcaceae	spp	X	X
	Chlorogonium	spp	X	
	Closterium	spp		X
	Cosmarium	*tenue*		X
	Dictyosphaerium	*chlorelloides*		X
	Lagerheimia	*quadriseta*		X
	Micractinium	*pusillum*		X
	Mougeotia	spp	X	X
	Oocystis	*parva*	X	X
	Oocystis	*pusilla*		X
	Pediastrum	*simplex*	X	X
	Pediastrum	spp		X
	Phacotus	*lendneri*		X
	Quadrigula	*lacustris*		X
	Scenedesmus	spp	X	
	Schroederia	*judayi*	X	
	Tetraedron	*regulare*		X
Chrysophyta	*Dinobryon*	spp	X	
	Mallomonas	spp		X
Cryptophyta	*Rhodomonas*	*minuta*	X	
Cyanophyta	*Anabaena*	*aphanizomenoides*		X
	Anabaena	*macrospora*		X
	Anabaena	*planctonica*	X	X
	Aphanizomenon	*flos-aquae*	X	
	Aphanocapsa	*delicatissima*	X	
	Aphanothece	*nidulans*	X	
	Coelosphaerium	*naegelianum*	X	
	Cylindrospermopsis	*raciborskii*		X
	Gomphosphaeria	*lacustris*		X
	Lyngbya	*lagerheimia*		X
	Lyngbya	*limnetica*	X	X
	Lyngbya	*subtilis*		X
	Merismopedia	*tenuissima*	X	X
	Merismopedia	*warmingiana*	X	
	Microcystis	*flos-aquqe*	X	
	Oscillatoria	*agardhii*	X	X
	Oscillatoria	*amphibia*	X	X
	Planktothrix	*isothrix*		X
	Synechococcus	*elongatus*		X
	Synechocystis	spp	X	X
Miscellaneous		spp		X
Pyrrhophyta	*Ceratium*	*hirundinella*	X	X
	Peridinium	*umbonatum*	X	
Xanthophyta	*Centratractus*	*belonophorus*		X

The Indiana Clean Lakes Program data from 2003 shows Center Lake as it compares to other lakes in Kosciusko County (Table 19). Silver Lake is similar in size to Center Lake and does not appear to be as healthy. The mean Chlorophyll A value for Center Lake is very close to being equal to the minimum value, this indicates that the maximum occurred during a relatively short lived condition not indicative of the typical lake water condition.

TABLE 19 – CHLOROPHYLL A SUMMARY DATA FOR KOSCIUSKO COUNTY, 2003.

Lake Name	Acreage	Min (µg/L)	Max (µg/L)	July/Aug Mean (µg/L)	Carlson's Chl-A TSI
Big Chapman	512	0.8	3.9	3.9	49
Center	120	1.5	26.1	1.6	43
Silver	100	22.0	45.4	31.4	63
Syracuse	414	0.4	0.4	0.4	34
Tippecanoe	500	0.3	3.7	3.7	48
Wawasee	3,410	2.5	5.9	2.5	46

Lower Chlorophyll A values and lower Carlson's Chlorophyll A – Trophic State Index values are indicative of healthier lake systems. Further discussion of these water quality conditions are discussed in Section 8.0 - Trophic Conditions Versus Historical Data of this diagnostic study report.

Chlorophyll A is contained in all green plants and is used as a trophic state indicator. There is generally a good agreement between planktonic primary production and algal biomass. Excessive algal biomass is a result of eutrophication. However it is more difficult to measure algal biomass then it is to measure Chlorophyll A.

3.7 Nuisance Species

The Center Lake watershed contains several nuisance species that are of concern and the most significant of these species are discussed within this section. The public boat launch for Center Lake is posted with an Exotic Species Advisory. The species listed on this advisory include the zebra mussel, spiny water flea, round goby and Eurasian water-milfoil. At present the most problematic of these species is the Eurasian water-milfoil with has out competed native aquatic vegetation in portions of the lake and has been controlled by physical, chemical and biological methods to date.

<u>Eurasian water-milfoil</u> (*Myriophyllum spicatum*), which is native to Europe, Asia and North Africa, was observed by V3 ecologists during the aquatic plant survey. Eurasian water-milfoil forms thick underwater tangles of stems with vast mats of vegetation breaking through the surface of the water. The stems become wrapped around boat propellers, and the vegetative mats are nearly impossible to swim through. The dense mats are so thick that it impairs the ability of predatory fish to catch smaller fish, often leading to an overpopulated and stunted fish community.

Eurasion water-milfoil has the ability to grow from stem fragments and stolons (specialized stems that creep over the lake bottom). A fragment as small as one stem segment with leaves can take root and grow. Fortunately, this plant has difficulty becoming established in lakes with an undisturbed native plant community. However, it is able to quickly take advantage of any disturbed area, and its growth habitat allows it to rapidly dominate a lake and shade out native plants. It is very easy to transport Eurasian water-milfoil from lake to lake on boats, trailers, anchors, personal watercraft or any other equipment that moves from lake to lake (IEPA and NIPC, 1996).

<u>Common carp</u> (*Cyprinus carpio*), a fish native to Europe, were observed by V3 ecologists within the channel north of Center Lake on both sides of the water control structure. Common carp were also collected during the 2001 IDNR fisheries survey. Common carp can tolerate water with extremely low oxygen levels and high temperatures, unlike many native fish that perish under such conditions. They posses an acute sense of smell, taste and hearing that allow them to function well in low light conditions, giving them a competitive advantage over sight-feeding fish such as sunfish, bass and perch. In fact, the bottom feeding habits perpetuate the low light conditions in which they excel, allowing common carp to out-compete other fish species for food.

Common carp feed by rooting along the bottom, pushing their snouts through silty substrates. Lakes with significant carp populations can have their water clarity reduced to a few inches by their feeding activities. Furthermore, existing aquatic plants are uprooted by the common carp and new plants cannot become established due to the low water clarity and continued bottom disturbance. By disturbing sediments, carp promote the recycling of nutrients to the overlying waterbody, creating the potential for increased algae growth (IEPA and NIPC, 1996).

<u>Zebra mussel</u> (*Dreissena polymorpha*), a fingernail-sized mussel native to the Caspian Sea area of Asia, were collected by V3 ecologists at the Tippecanoe River and Long Ditch water quality sampling locations. Both of these waterways are tributary to Center Lake during highflow conditions. Zebra mussels cause economic damage by clogging intake pipes of water treatment and power plants as well as boat engine cooling systems. Ecologically, they have reduced and may eradicate native mussel species by colonizing upon them in huge numbers and essentially smothering them. Zebra mussels can become so dense (30,000 to 70,000 per square yard) that their filtering activity (up to a quart of water per day per mussel) can have a dramatic effect on the surrounding waterbody. By filtering plankton out of the water, they can significantly increase water clarity and change the ecological structure of the lake community.

Zebra mussels were originally introduced to North America through the bilge water of an oceangoing vessel and have used similar means to travel to new lakes and rivers since their arrival. The adult mussels can survive out of water for several days. Zebra mussel larvae (called veligers) can be transported in engine cooling water, live wells, bilges, etc… (IEPA and NIPC, 1996).

<u>Purple loosestrife</u> (*Lythrum salicaria*), introduced to the United States as an ornamental plant, was observed by V3 ecologists during the aquatic plant survey. Purple loosestrife grows in very dense masses in wetland environments and along lake shorelines. It can take over a wetland or shoreline, becoming virtually the only plant growing in the area by literally shading out native species. Wildlife numbers also decline in a purple loosestrife dominated system due to the reduction in habitat diversity and the limited habitat and reduced food value purple loosestrife provides.

Purple loosestrife spreads primarily from seed. Each plant can produce as many as 2,000,000 seeds each year, although plants also can grow from broken stems that root in moist soil. Seeds may lie dormant for several years waiting for appropriate conditions. Any area that has supported purple loosestrife in the past is likely to have a large bank of dormant seeds in the surrounding soil. The seeds are easily carried by animals or flowing water. Most sunny wetlands or shorelines are suitable habitat for this plant. Chances of colonization are greatly enhanced by disturbances such as water drawdown, damaged vegetation, or exposed soils. Invasion by purple loosestrife usually begins with a few pioneering plants that build up a seedbank in the soil. When an appropriate disturbance comes along, the population explodes (IEPA and NIPC, 1996).

Canada goose (*Branta canadensis*), are a native water fowl that can become a nuisance when they stop their migratory lifestyle and become permanent residents. Canada geese were observed by V3 ecologists on numerous visits to Center Lake. During their nesting season and while raising their young, Canada geese become extreamly defensive of their territory and pose a potential hazard by creating unsafe situations for small children and unsuspecting adults. The geese can cause economic damage to an area by overgrazing. An adult Canada goose eats up to four pounds of grass daily. They can render the open park space and beach front unusable with an excessive amount of droppings. An adult Canada goose deposits 2 pounds of fecal matter daily. In addition to being unsightly, the excessive amount of fecal matter from geese can cause health concerns as well, as it has been linked to the spread of diseases and bacterial infections.

One resident Canada goose produces 0.5 pounds of phosphorus per year. This quantity of phosphorus multiplied by a large resident flock can pose a significant phosphorus loading issue to water quality. This increase in nutrient load provides appropriate conditions for algae growth, and in turn can alter the entire ecosystem of the lake.

Muskrat (*Ondatra zibethica*), is a native semi-aquatic rodent that generally inhabits wetlands with an abundant supply of aquatic vegetation. V3 ecologists observed muskrats at Center Lake on more than one site visit. The primary diet of a muskrat includes cattails, arrowhead and duckweed. Occasionally they will eat crayfish, snails, mussels, frogs, insects and slow-moving fish.

Muskrats make their homes in bank dens or lodges similar to those of the beaver but smaller in size. They excavate dens by burrowing into the banks with their front claws. The dens are complete with dry chambers and underwater tunnels, and there are ventilation holes that are hidden at the surface by shrubs, branches or thick vegetation. The lodges, constructed with aquatic plants, brush and mud, are usually situated on a foundation of brush or a stump or are occasionally built up from the bottom of the wetland. Several small feeding huts that are similar to the lodges may be constructed within the muskrat’s territory.

Muskrats become a nuisance when their feeding and burrowing activities cause damage to gardens, crops, shorelines or dikes.

4.0 WATER BUDGET

Water Budgets are very useful in determining significant water sources and hydrologic influences that may affect lake water quality. Water budgets are the basis for determining how much time water particles may spend in the lake, which assists interpretations regarding the capture and retention of nutrients and sediments within the lake. The principal parameter of interest in lake restoration is hydraulic residence time. Residence time is defined as the length of time required for the entire volume of the lake to be replaced with “new” water from runoff and direct precipitation, and defines how dynamic the lake is and how responsive it will be to changes in nutrients loading.

The water budget for Center Lake is conceptually developed as follows:

Inputs – Water enters Center Lake from the following sources:

- Direct precipitation to the lake
- Sheet runoff from land immediately adjacent to the lake
- Lones Ditch to the north of Center Lake which is connected to Pike Lake
- Under occasional rainfall events (flood flows), water input from Tippecanoe River and Walnut Creek
- Groundwater

Outputs – Water leaves Center Lake from:

- Evaporation
- Outflow to the west into Walnut Creek through a dam
- During low flow conditions, it has been reported that water may exit Center Lake at both the Walnut Creek Dam (outlet) and the Center Lake (inlet)

Accurately quantifying the Center Lake water budget is made difficult by a significant lack of information and existing record from which to estimate the quantity of water input from the Tippecanoe River and Walnut Creek during the aforementioned flood flows. Additionally, no groundwater data is available for this lake sufficient to develop estimates for ground water inputs and outputs. Therefore, for the purpose of this study, we first assume that groundwater input is equal to groundwater output. Second, we develop two separate water budgets—one based on the direct tributary watershed and one based on the overall Center Lake watershed—thus providing a range of possible inputs to Center Lake.

Based on these two separate water budgets, we calculated an initial Center Lake residence time based on the direct tributary (USGS) Center Lake watershed. This was done to obtain a more conservative value (longest likely residence time), given the uncertainty associated with inflows from Walnut Creek and the Tippecanoe River sub-watersheds. We also calculated second residence time based on runoff from the overall watershed. This provides an unrealistically low, but instructive lower end for Center Lake residence time.

Assuming groundwater inflows equal groundwater outflows, the formula for calculating residence time is as follows:

$$\tau = \frac{V}{R + (P - E)} \text{ --- } \textit{Equation 1.0}$$

Where:

τ = Hydraulic Residence Time (Years)
V = Lake volume (acres-feet)
R = Average annual runoff (acres-feet/year)
P = Precipitation (acre-feet/year)
E = Evaporative losses (acre-feet/year)

<u>Lake Volume (V)</u>
The volume of the lake was estimated using the *Prismoidal Assumption* (personal communication, Dr Sri Sritharian, Central State University Water Resources Management Department) according to the following equation:

$$V = \frac{1}{3} h \times A \text{ -- } \textit{Equation 2.0}$$

Where:

A= Area of lake (acres)
h = maximum depth of lake (feet)

The volume of the lake was estimated to be 1,680 acre-feet.

<u>Runoff (R)</u>
Runoff from the Direct Tributary Center Lake watershed (R_{DT}) was calculated as well as the runoff from the Overall Center Lake watershed (R_O). In doing so, a range of minimum and maximum runoff volumes to Center Lake was developed.

There are no discharge gages in the watershed to measure runoff values so the annual runoff value for Center Lake was estimated based on USGS reported runoff values for Tippecanoe River at Oswego (12.91 inches) and Walnut Creek near Warsaw (12.60 inches). Observing that runoff values are about 12 inches in neighboring water bodies, we concluded that the annual runoff at Center Lake was about 12.75 inches (average of runoff value at Walnut Creek and at Tippecanoe River).

The annual runoff from the 467.2 acres direct tributary Center Lake watershed (R_{DT}) was obtained by multiplying the watershed area by above annual runoff rate of 12.75 inches. The value obtained was R_{DT} = *496.4 acre-feet*. The annual runoff from the 9,611 acres overall Center Lake watershed was obtained by multiplying the area by the annual runoff rate of 12.75 inches. The value obtained was R_O = *10,211.7 acre-feet*.

Precipitation (P)
The average annual precipitation (P) was determined by multiplying the lake area by the reported annual precipitation for Kosciusko County of 38.5 in/year (USGS 2002 Data Report).

Evaporation (E)
The National Oceanic and Atmospheric Administration (NOAA) obtained evaporation rates for six sites of which Valparaiso was the closest to Warsaw, Indiana. The annual pan evaporation rate in Valparaiso was 28.05 inches. Pan evaporation overestimates lake evaporation by 40% (Chow, 1964) therefore the annual evaporation rate used for Center Lake was 16.83 inches. Multiplying this rate by the area of Center Lake yields the volume of evaporation losses for Center Lake.

The hydrologic characteristics of Center Lake are summarized within Table 20.

TABLE 20 – HYDROLOGIC CHARACTERISTICS OF CENTER LAKE

Parameter	**Value**
Annual Runoff (R_{DT}) from the Direct Tributary Center Lake Watershed (acre-feet)	496.4
Annual runoff (R_O) from the Overall Watershed for Center Lake (acres-feet)	10,211.7
Annual Precipitation (P)*	384
Annual Evaporation (E)	169.2

*Source = USGS Data Report Water Year 2002

Hydraulic Residence Time (τ)
Using equation 1.0, the calculated residence time for a particle originating from the direct tributary Center Lake watershed is $\boldsymbol{\tau_{DT}}$ ***= 2.35 years (857.7 days)***. The calculated residence time for a particle originating from the overall watershed of Center Lake is $\boldsymbol{\tau_O}$ ***= 0.16 year (58.4 days)***.

Discussion and Conclusions
The result of the residence time determinations for Center Lake shows that the time necessary for the lake to "renew" its water lies between 58.4 and 530 days. The large difference between these two values is the result of the large differences in land area between the direct tributary watershed and the overall watershed. Since, within the scope of this diagnostic study, we have no means of quantifying the periodic inflows resulting from flood level contributions from Pike Lake (Lone Ditch), Tippecanoe River, and Walnut Creek, this range is used to instruct decisions regarding lake management. It is clear, although not quantified, that inflows to Center Lake from the overall watershed represent only a fraction of the total annual runoff from those areas outside the direct tributary Center Lake watershed. As a result, we would correctly conclude that that actual Center Lake residence times are on the higher end of the calculated range, likely on the order of several months.

5.0 LAKE SHORELINE AND STREAMBANK EROSION

Figure 15 depicts the condition of Center Lake's shoreline. Table 21 lists the existing shoreline types and the linear measure of each. Since the V3 shoreline assessment during July 17 and 18, 2003, portions of the natural shoreline have been stabilized with various bioengineering stabilization methods. This portion is along the Lakewood Hills Condo Association property. Figure 15 depicts this condition as field stone, although during the July 2003 survey the condition of this shoreline was natural.

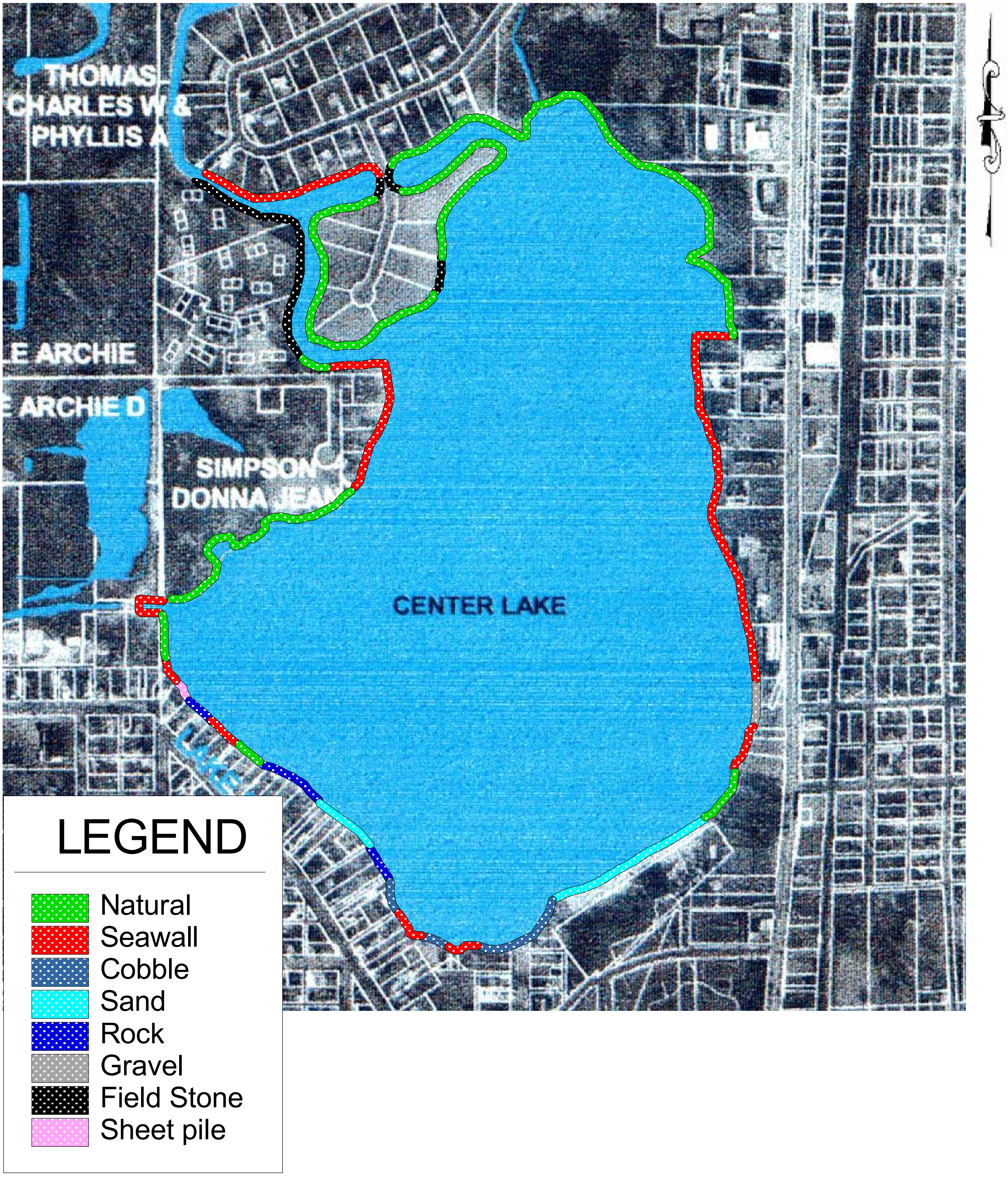
TABLE 21 – LAKE SHORELINE SURVEY AT CENTER LAKE, JULY 17 AND 18, 2003.

Shoreline Type	Linear Distance (feet)
Natural	6,405
Seawall	4,710
Cobble	760
Sand	1,070
Rock	600
Gravel	195
Field Stone	1,400
Sheet pile	65

The shoreline surrounding Center Lake is not contributing a significant degradation to the water quality or habitat, as there does not appear to be any stretches where severe erosion is taking place. However, severe streambank erosion was observed during May 29 and 30, 2003 along the Tippecanoe River, as noted in photo 6. This condition of erosion is indicative of scouring that takes place during spring storm events, when water levels are higher than normal and flow velocities are faster than normal. The silt that is being eroded along these banks is contributing to the sedimentation of silt within the Lones Ditch and channel north of Center Lake. In addition, some residents have noted the lake shorelines along Center Lake can erode at an alarming rate of up to one foot per year, if not maintained by some type of protective stabilization or vegetative cover that can withstand waves from the wind fetch.

In addition to the streambank erosion along the Tippecanoe River, silt also erodes from upland locations and agricultural lands within the watershed. This adds to the magnitude of silt that is carried in the Tippecanoe River as bedload and is the source of the sedimentation problem that is occurring within the channel north of Center Lake as well as the northwestern portions of Center Lake itself.

Photo 6 – Severe bank erosion, Tippecanoe River



V3 CONSULTANTS Engineers • Scientists • Surveyors 7325 Janes Avenue, Suite 100 Woodridge, Illinois 60517 (630) 724-9200	Title: Center Lake Shoreline Exhibit	Project: Center Lake	
	Client: Center Lake Conservation Association	Project No. 02218	Figure: 15	Sheet: 1 Of: 1
		File Name: N/A	Effective Date: 1/08/04	Scale: NTS

6.0 SEDIMENTATION ANALYSIS

Sediment analysis was performed at various locations throughout the lake from depths of 40 feet to the near shore reaches. There is not a significant accumulation of sediment within the central area of Center Lake. The main body of the lake does not posses a sedimentation condition that would be categorized as a problematic. However, the north channel which connects Lones Ditch and Tippecanoe River to Center Lake does posses a problematic sedimentation condition. Sediment loads which enter from Pike Lake, Lones Ditch and the Tippecanoe River settle out along this channelized area.

This channelized section extending north of Center Lake does posses a significant amount of deposited sediment. This can be seen by the sediment plumes that are created by boat propellers. This channel receives limited water flow through it, occasionally the flow is into the lake and sometimes the flow is out from the lake, but for the most part the water remains stagnant. Members of the CLCA and V3 kayaked within the surface water connections to Center Lake on May 31, 2003. The turbidity levels in the waters from Lones Ditch (Pike Lake outlet) and the channel north of Center Lake were easily observed. By placing a paddle into the sediment one could release the gasses produced by decaying materials from within the sediment. The north channel was dredged south (the lake side) of the control structure in order to create it and has not been maintained by subsequent dredging since its creation. The channel north of the control structure, which connects to Lones Ditch, has never been dredged. The sediment of Center Lake is shown in Photo 7.

Photo 7 – Lake Sediment

Our recommendations will attempt to address how to alleviate the sedimentation deposits within this channelized section, so that further issues do not arise from this area. Dredging activities within the central area of Center Lake are not likely to improve the water quality of Center Lake. However, the elimination of sediment loading through watershed improvements in the north channel and the dredging of accumulated sediment within this channel would contribute to the improved water quality of Center Lake. The IDNR is in the process of developing criteria for the LARE program that would allow for dredging activities. The north channel to Center Lake may be eligible for this funding, as this channel is an inlet and improvements can be made which will prevent the continued input of sediment to the lake. This funding may be available by July of 2005, if the grant for funding is applied for by January 2005.

7.0 NONPOINT SOURCE POLLUTION

The characteristics of watershed areas greatly influence the quality of the respective receiving water, in this case Center Lake. Lakes with high watershed area to lake area have the potential to receive more pollutants from runoff than lakes with small watershed area to lake area. Based on the direct tributary watershed, watershed area to lake area is approximately 4:1. Using the overall watershed, watershed area to lake area is 80:1. However, this latter ratio is not representative as an interpretive characteristic because of the aforementioned complexities related to the nature of periodic high water inflows to Center Lake from the Tippecanoe River, Lones Ditch and Walnut Creek. However, the range can be instructive as we consider the realities facing Center Lake that are developed in the following discussions.

<u>Modeling Methods</u>

This section describes the efforts taken to quantify the nutrient and sediment loading to Center Lake. A conceptual model of the overall Center Lake watershed and its characteristics was developed using BASINS (Better Assessment Science Integrating Point and Non-point Sources). Using the BASINS as the primary modeling platform, PLoad software was used to model non-point source nutrient and sediment loads. Available land use information along with pollutant-loading rates from the National Urban Runoff Program (NURP) were provided as inputs to the PLoad model to determine the nutrients and sediments delivery from the previously described sub-watersheds. PLoad's "Export Coefficient Method" was used to determine non-point source pollutant loads from each land type and sub-watershed. The pollutant loads are calculated by multiplying the pollutant-loading rate for each specific land use (from NURP) by the area of that land type (see Equation 3.0).

$Lp = (Lpu * Au)$ ---*Equation 3.0*

Where:

Lp = Pollutant load, lbs
Lpu = Pollutant loading rate for land use type u, lbs/acre/year
Au = Area of land use type u, acres

<u>Results and Conclusions</u>

The pollutant load modeling results are summarized on Table 22 and illustrated in Figures 16 through 20. As shown on Table 22, the Tippecanoe River sub-watershed delivers the largest Total Nitrogen (TKN) and dissolved phosphorous (DP) load per acre. This is not surprising given the Tippecanoe sub-watershed is 67.9% cropland and pasture, which contributes a significant source of nutrient loading. Although the Pike/Center Lake and Walnut Creek sub-watersheds are comprised of the same acreage of cropland and pasture (312.7 acres and 311.8 acres, respectively), Walnut Creek contributes a slightly higher delivery of TKN and TP per acre—a result of other land use characteristics.

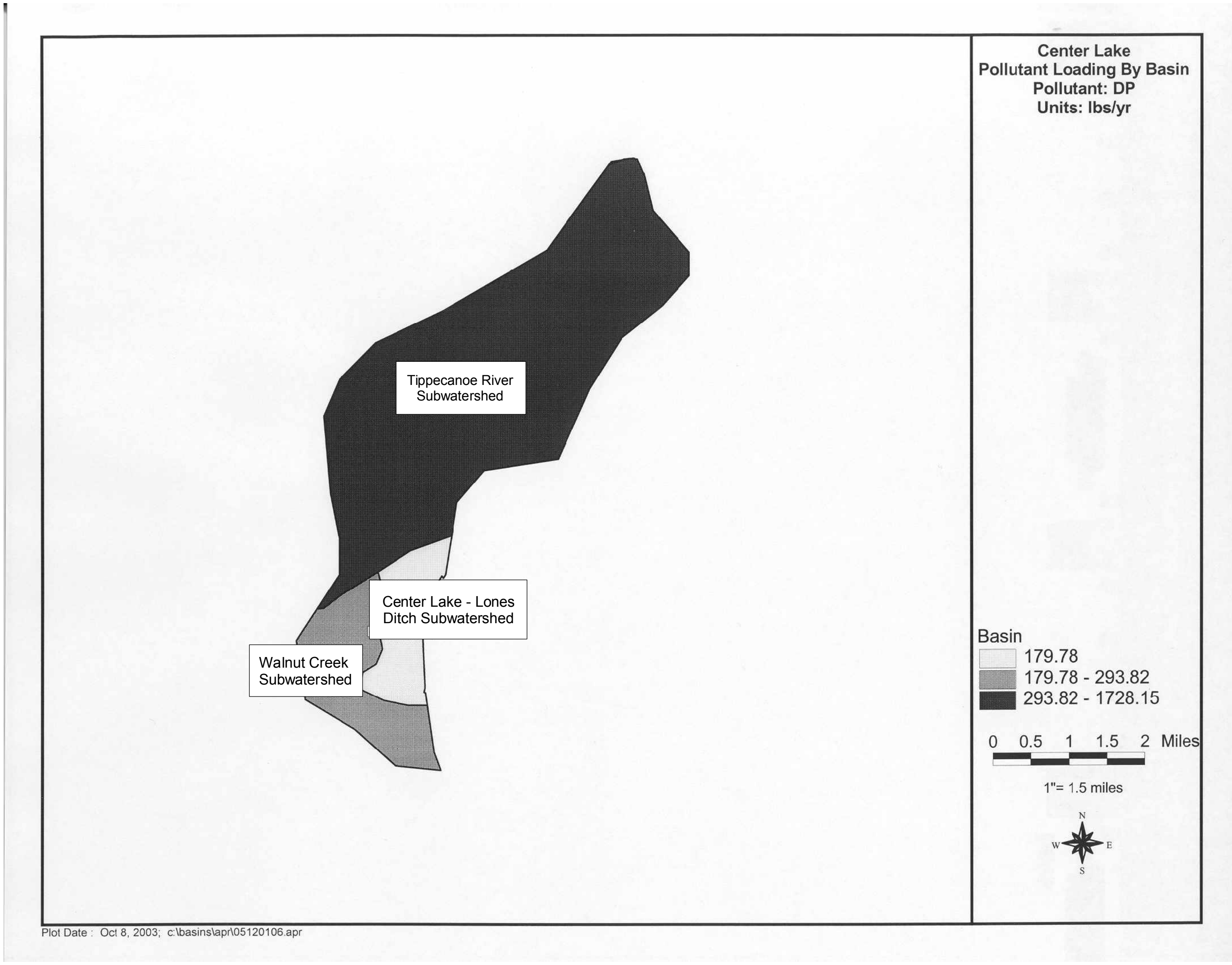
TABLE 22 – NUTRIENTS AND SEDIMENTS LOAD PER ACRE OF SUB-WATERSHED

	TKN (lbs/acre)	NOX (lbs/acre)	DP (lbs/acre)	NH3-N (lbs/acre)	TSS (lbs/acre)
Tippecanoe River	2.06-2.52	2.11-3.5	0.22-0.23	0.38	98.48-649.3
Walnut Creek	1.94-2.06	2.02	0.2-0.22	0.38-0.43	326.7-537.5
Pike/Center Lake	1.94	2.02-2.11	0.2	0.38	498.52
Total	**5.94 - 6.52**	**6.15 - 7.63**	**0.62 - 0.65**	**1.14 - 1.19**	**923.7 -1,685.32**

Discussion and Conclusions

Estimating the total annual nutrient loads to Center Lake is made difficult by the complexities related to the aforementioned periodic high water flows from the Tippecanoe River, Pike Lake (Lones Ditch), and Walnut Creek. As a result, we cannot accurately quantify the total mass of nutrient delivery to Center Lake. Instead, interpretations are made on a qualitative and semi-quantitative basis in relationship to sub-watershed total area and the relative difference in loading rates per acre between sub-watersheds.

On this basis, we can conclude that mass loading of nutrients and sediments flowing from the Walnut Creek sub-watershed and the Tippecanoe River sub-watershed are potentially significant. This conclusion is based on the extent of land under agricultural use, higher nutrients and sediment loading rates, and the large land area represented by these sub-watersheds. It is probable that flows received by Center Lake often capture "first flush" given that these periodic inflows occur during storm events, rather than low flow. First flush flows typically capture the largest proportion of nutrient and sediment mass resulting from storm runoff; with larger storm events generating even greater nutrient and sediment first flush mass.



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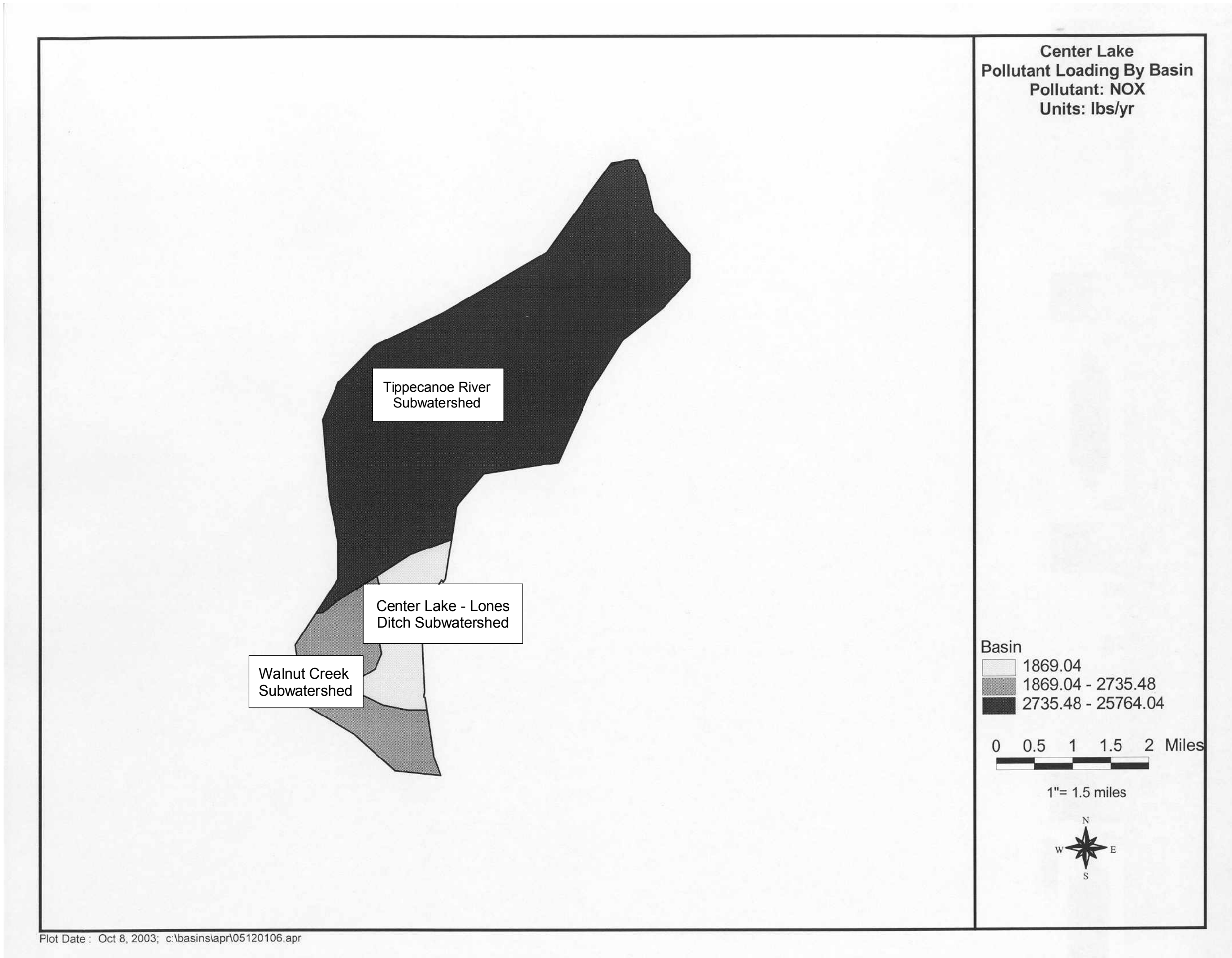
	Client: Center Lake Conservation Association	Project No. 02218	Figure: 16	Sheet: 1 Of: 1
		File Name: N/A	Effective Date: 1/08/04	Scale: NTS



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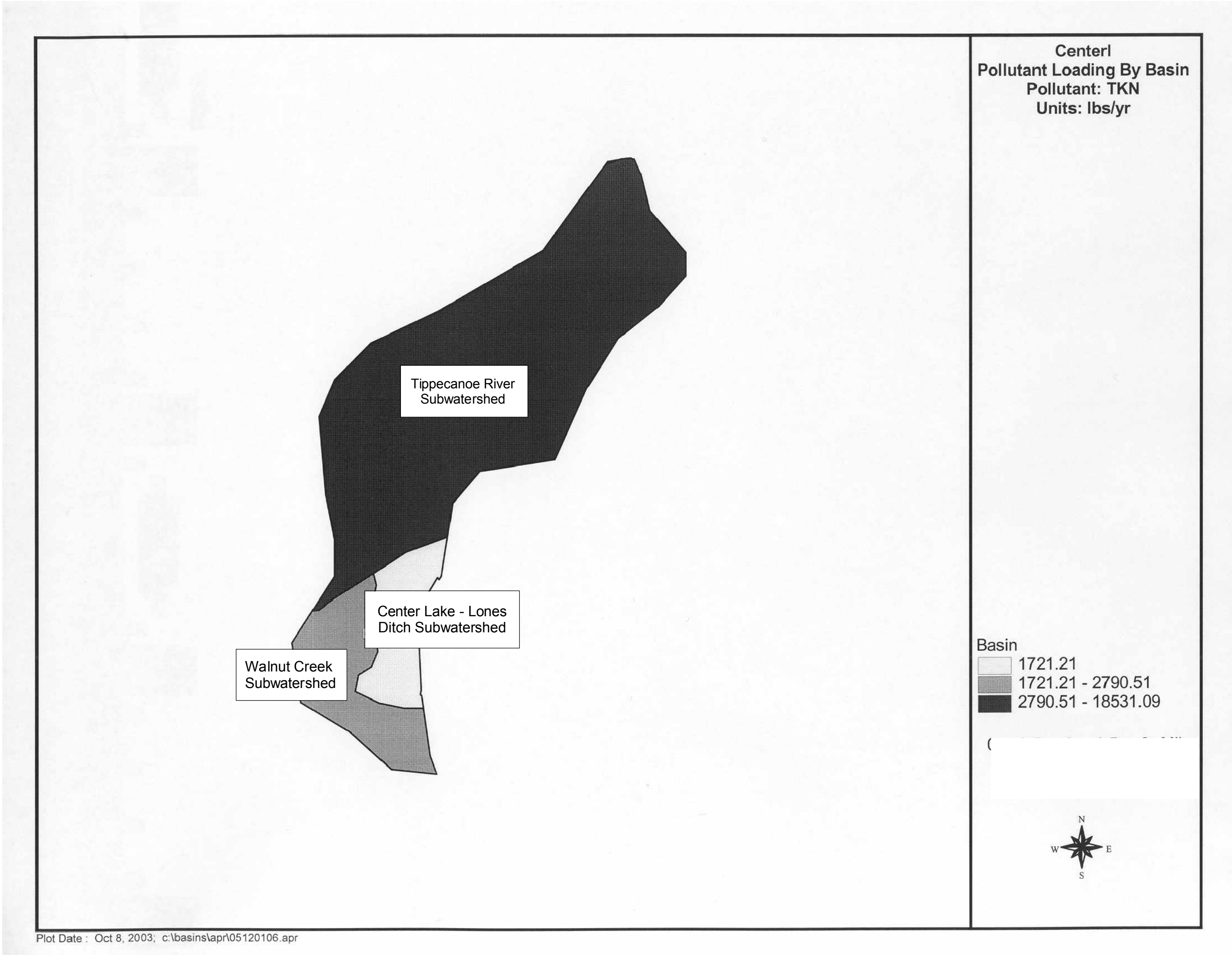
	File Name: N/A	Effective Date: 1/08/04	Scale: NTS



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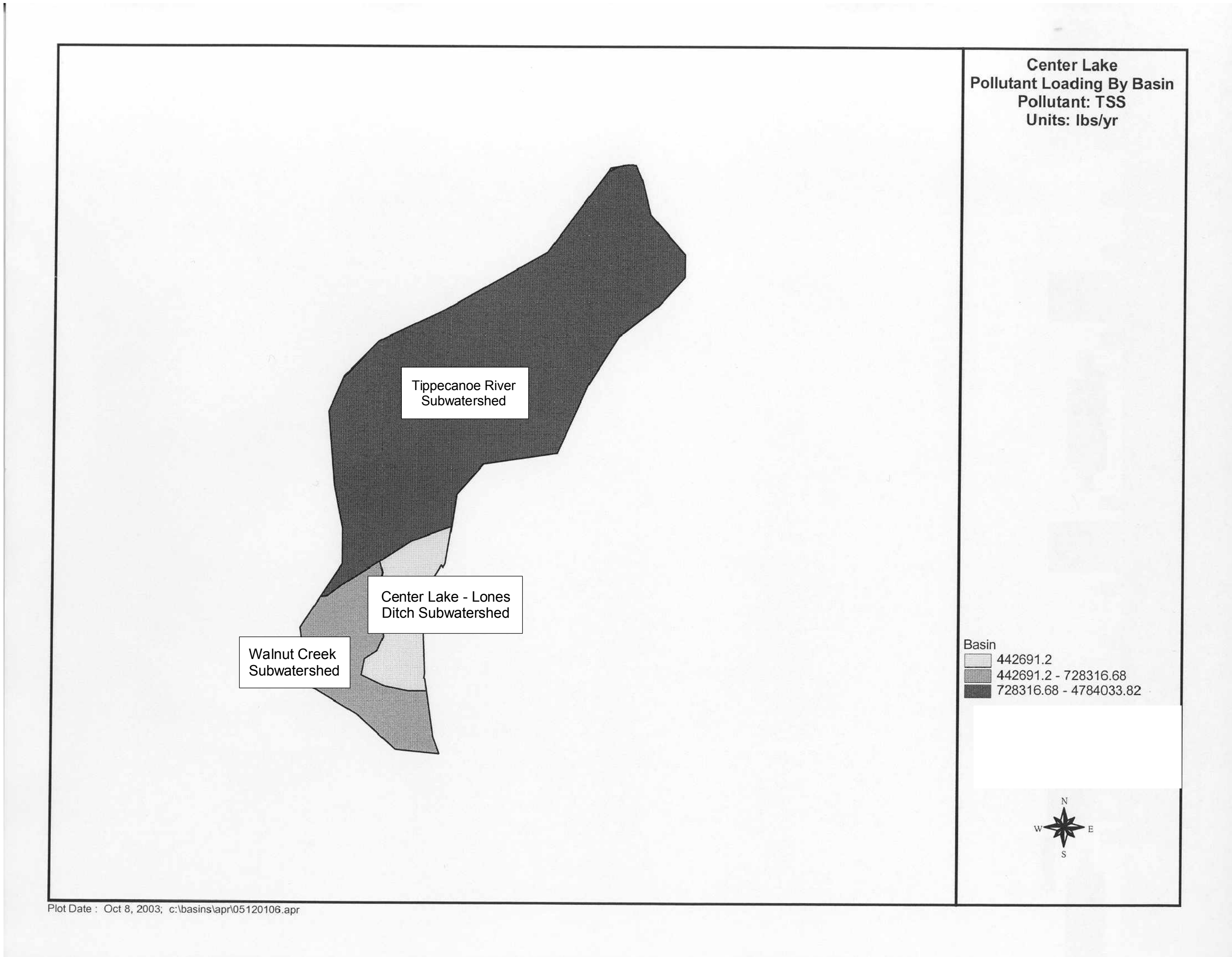
	Client: Center Lake Conservation Association	Project No. 02218	Figure: 18	Sheet: 1 Of: 1
		File Name: N/A	Effective Date: 1/08/04	Scale: NTS



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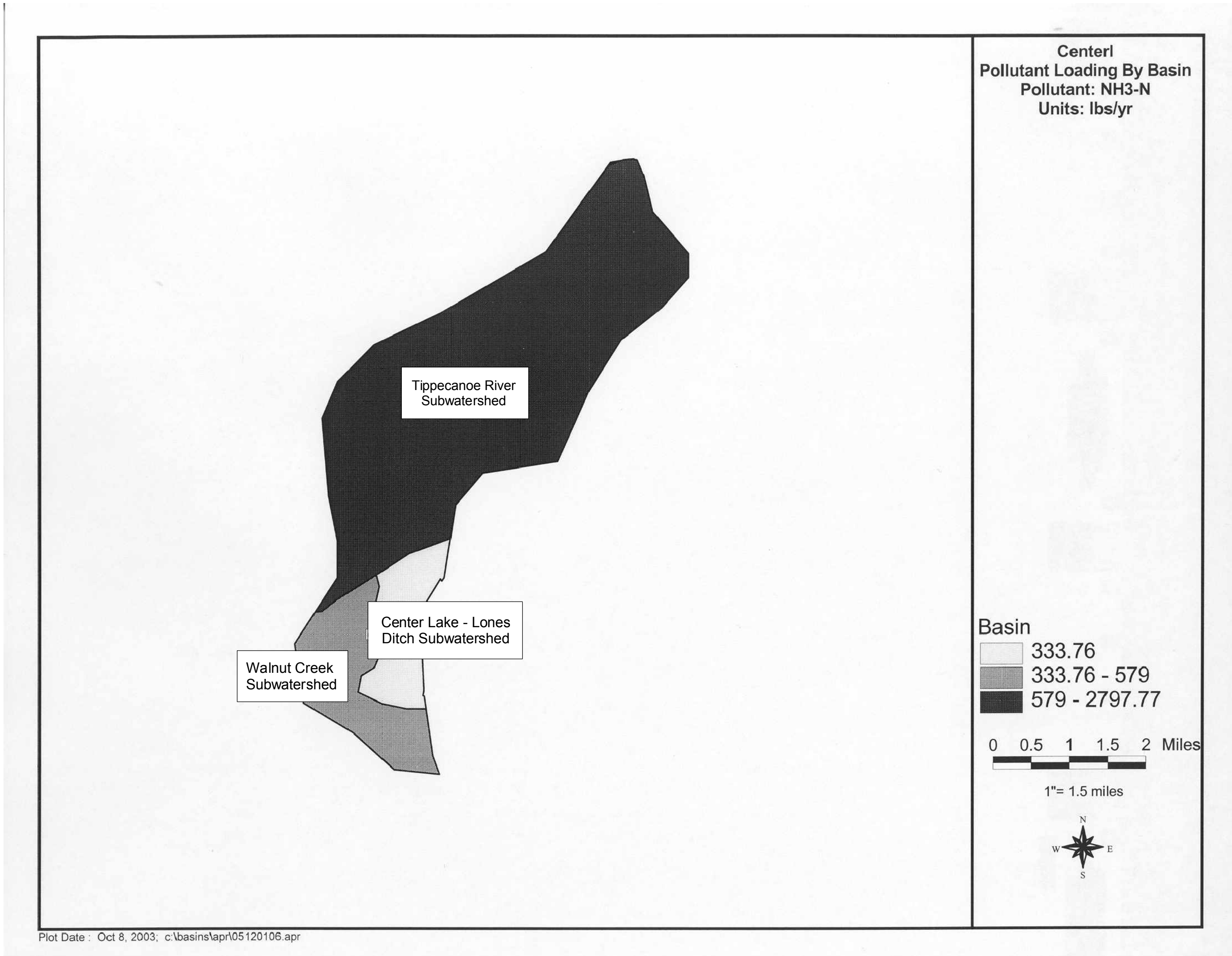
Client: Center Lake Conservation Association	Project No. 02218	Figure: 19	Sheet: 1 Of: 1
	File Name: N/A	Effective Date: 1/08/04	Scale: NTS



V3 CONSULTANTS Engineers • Scientists • Surveyors 7325 Janes Avenue, Suite 100 Woodridge, Illinois 60517 (630) 724-9200	Title: **NH3-N Pollutant Loading By Basin Exhibit**	Project: Center Lake	
	Client: Center Lake Conservation Association	Project No. 02218	Figure: 20	Sheet: 1 Of: 1
		File Name: N/A	Effective Date: 1/08/04	Scale: NTS

8.0 TROPHIC CONDITIONS VERSUS HISTORICAL DATA

Interpreting water quality data can be quite complicated because the characteristics and resulting behavior of lakes and their watersheds differ. In most lake studies there is special attention paid to aquatic plant nutrients (phosphorus and nitrogen) and lake transparency (Secchi disk). Those factors are used to help identify the trophic state of the lake and, therefore, its "general health".

Water quality data is often compared to criteria that most limnologists agree upon. In this study, data will be analyzed using Vollenweider's data, the Indiana Department of Natural Resources Trophic State Index (TSI), and Carlson's Trophic State Index.

<u>Comparison With Vollenweider's Data</u>
In a study conducted in 1970, Richard Vollenweider used relevant water quality parameters to determine the trophic status of a lake. These values are used only as a guideline and it is understood that similar concentrations in a particular lake may not cause the same problems if some other chemical is acting as the limiting nutrient. Values from Vollenweider's study are given either in milligram per liter (mg/L) or in micrograms per liter (ug/L). Table 23 shows the Vollenweider water quality values as they generally relate to the trophic status of lakes.

TABLE 23 – MEAN WATER QUALITY PARAMETERS AS COMPARED TO TROPHIC STATUS

Parameter	Oligotrophic	Mesotrophic	Eutrophic	Hypertrophic
Total Phosphorus (mg/L or ppm)	0.008	0.027	0.084	>0.750
Total Nitrogen (mg/L or ppm)	0.661	0.753	1.875	---
Chrorophyll *a* (μg/L or ppb)	1.7	4.7	14.3	---

Table 24 shows historic and current total phosphorus and total nitrogen concentrations in Center Lake. In general, total nutrients concentrations have been increasing from 1994 to present. The trend is towards increased eutrophication, and is thus opposite the trend needed for improving lake conditions.

When compared with the Vollenweider guidelines above, Center Lake historical and current total phosphorus concentrations suggest that it is an eutrophic lake. This appears to hold true when evaluating available nitrogen data as well.

TABLE 24 – CENTER LAKE TOTAL NITROGEN, TOTAL PHOSPHORUS, AND CHLOROPHYLL A CONCENTRATIONS FROM 1994 TO PRESENT

Year	Total Phosphorus (mg/L)		Total Nitrogen (mg/L)		Chlorophyll A (μg/L)
	Top	*Bottom*	*Top*	*Bottom*	
1994*	0.01	0.2275	0.552	1.561	8.92
1998*	0.015	0.037	0.489	0.502	8.62
2003	<0.05	0.46	<1	3.3	---

* = Source Indiana Department of Environmental Management

Indiana Trophic State Index (TSI)

Indiana, and many other states, use a "trophic state index" (TSI) to help identify the status of lakes. Indiana's TSI uses a set of parameters to which an index, or eutrophy number, is assigned. The index total, or TSI, is the sum of the individual eutrophy points for the lake. The Indiana TSI varies from 0 to 75 total points indexed to the classifications shown in Table 25.

TABLE 25 – INDIANA TSI CLASSIFICATION

Indiana TSI Scores	EPA Trophic Class
0-15	Oligotrophic
16-31	Mesotrophic
32-46	Eutrophic
47-75	Hyper Eutrophic
Varied, but with dysfunctional feeding due to other influences (i.e tannic)	Dystrophic

Source: Indiana Department of Environmental Management: Lake Classes used in the 305(B) Report after 1999

A rising TSI suggests worsening water conditions in the lake while a decreasing TSI indicates improving conditions in the lake. Table 26 shows the parameters and assigned eutrophy points used to calculate the Indiana TSI.

TABLE 26 – THE INDIANA TROPHIC STATE INDEX

	Parameter and Range		*Eutrophy Points*
I	Total Phosphorus (mg/L)		
	A.	Below 0.03	0
	B.	At Least 0.03	1
	C.	0.04 to 0.05	2
	D.	0.06 to .19	3
	E.	0.2 to 0.99	4
	F.	1.0 or more	5
II.	Soluble Phosphorus (mg/L)		
	A.	Below 0.03	0
	B.	At Least 0.03	1
	C.	0.04 to 0.05	2
	D.	0.06 to .19	3
	E.	0.2 to 0.99	4
	F.	1.0 or more	5

ADDENDUM:

TABLE 24A – CENTER LAKE TOTAL NITROGEN, TOTAL PHOSPHORUS, AND CHLOROPHYLL A CONCENTRATIONS FROM 1994 TO PRESENT

Year	**Total Phosphorus (mg/L)**		**Total Nitrogen (mg/L)**		**Chlorophyll A** (µg/L**)**
	Top	*Bottom*	*Top*	*Bottom*	
1994*	0.01	0.2275	0.552	1.561	8.92
1998*	0.015	0.037	0.489	0.502	8.62
2003	<0.05	0.46	<1	3.3	112.00**

* = Source Indiana Department of Environmental Management

** = Data collected on August 16, 2005

	Parameter and Range		*Eutrophy Points*
III.	Organic Nitrogen (mg/L)		
	A.	Below 0.5	0
	B.	At Least 0.5	1
	C.	0.6 to 0.8	2
	D.	0.9 to 1.9	3
	E.	2.0 or more	4
IV.	Nitrate (mg/L)		
	A.	Below 0.3	0
	B.	At Least 0.3	1
	C.	0.4 to 0.8	2
	D.	0.9 to 1.9	3
	E.	2.0 or more	4
V.	Ammonia (mg/L)		
	A.	Below 0.3	0
	B.	At Least 0.3	1
	C.	0.4 to 0.5	2
	D.	0.6 to .09	3
	E.	1.0 or more	4
VI.	Dissolved Oxygen: Percent Saturation at 5 foot Depth		
	A.	114% or less	0
	B.	115% to 119%	1
	C.	120% to 129%	2
	D.	130% to 149%	3
	E.	150% or more	4
VII.	Dissolved Oxygen: Percent of measured water column with at least 0.1 mg/L dissolved oxygen		
	A.	28% or less	4
	B.	29% to 49%	3
	C.	50% to 65%	2
	D.	66% to 75%	1
	E.	76% to 100%	0

	Parameter and Range		*Eutrophy Points*
VIII.	Light Penetration (Secchi disk)		
	A.	Five feet or under	6
	B.	Greater than five feet	0
IX.	Light Transmission (Photocell): Percent of light transmission at a depth of 3 feet		
	A.	0 to 30%	4
	B.	31% to 50%	3
	C.	51% to 70%	2
	D.	71% or more	0
X.	Total Plankton per Liter of Water - sampled from a single vertical tow between the 1% light level and the surface		
	A.	Less than 3,000 organisms	0
	B.	3,000 to 6,000 organisms	1
	C.	6,001 to 16,000 organisms	2
	D.	16,001 to 26,000 organisms	3
	E.	26,001 to 36,000 organisms	4
	F.	36,001 to 60,000 organisms	5
	G.	60,001 to 95,000 organisms	10
	H.	95,001 to 150,000 organisms	15
	I.	150,001 to 500,000 organisms	20
	J.	<500,000 organisms	25
	K.	blue-green dominance	+10

Source: Indiana Department of Environmental Management

The Indiana TSI values calculated for Center Lake over the years are summarized on Table 27.

TABLE 27 – CENTER LAKE TROPHIC INDEX NUMBER 1975, 1987, 1991, 1994, AND 1998

Year	1975	1987	1991	1994	1998
TSI	31	5	23	16	8

While there is much variability year-to-year, we note a general decrease in the TSI values. Based on the TSI scores, Center Lake would classify as "oligotrophic" with fluctuating trends. This makes sense because the sampling events are just snapshots of the lake and a lot of the data points are missing. Additionally, the Indiana TSI values are considered poor indicators of the trophic state of a lake because they rely heavily on algae (Carol Newman, Indiana Department of Environmental Management, personal communication). Additionally, the Indiana TSI accounts poorly for nutrients and transparency within the lake.

<u>Carlson's Trophic State Index</u>

The Carlson's TSI uses a logarithmic transformation of the Secchi disk values as a measure of algal biomass on a scale of 0 to 110. Carlson found a statistically relevant correlation between the Secchi Disk transparency data, the total phosphorus data and the Chlorophyll A data of lakes. Using his method, knowing one of these parameters one can obtain the others.

As an example, a lake with a summer time Secchi disk depth of 3 m (9.84 feet) would have would generally have a Chlorophyll A value on the order of 4 μg/l and total phosphorus on the order of 15 μg/l, and would place the status of the lake in the mesotrophic category. Carlson's TSI is illustrated on Figure 21.

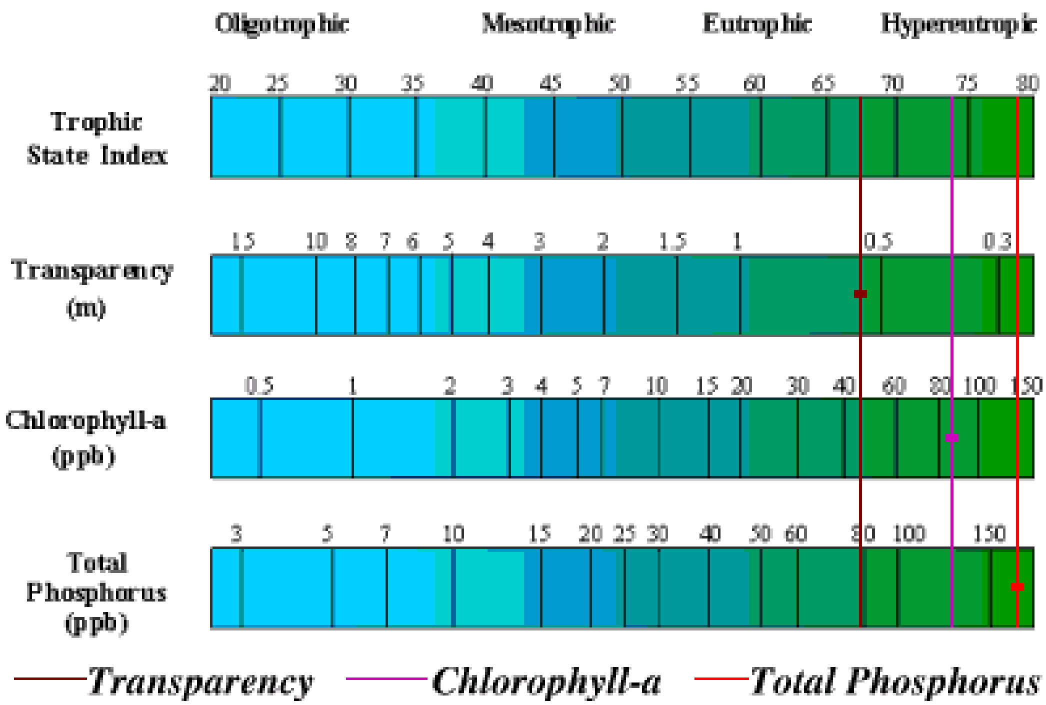


FIGURE 21 – CARLSON'S TROPHIC STATE INDEX

Using the historical and current Secchi transparency values for Center Lake shown earlier on Table 7 (Summary of Historical and Current Data for Center Lake) and comparing them the Carlson's TSI, the lake is found to be eutrophic.

Conclusions

Both the Vollenweider guidelines and the Carlson's TSI lead us to the conclusion that Center Lake is eutrophic.

9.0 POINT SOURCE POLLUTION

Point source pollution relates to direct "point" discharges such as an industrial process or sewer discharges. As related to this study, Table 28 lists National Pollution Discharges Elimination System (NPDES) permitted dischargers in the Center/Pike Lake sub-watershed. Four of the six facilities are active while the other two are inactive. All four active facilities discharge to the

Tippecanoe River through different tributaries and are not direct contributors to Center Lake water quality. However, because of the different surface water interconnections between Tippecanoe River, Walnut Creek and Center Lake, we expect potential influences on Center Lake water quality, more so as a general characteristic of these water bodies rather than the point sources themselves. The scope of the diagnostic study did not allow for the determination of the extent of the influence of these dischargers to Tippecanoe River and Walnut Creek.

TABLE 28 – NPDES FACILITIES IN THE CENTER LAKE/PIKE LAKE SUB-WATERSHED

FACILITY	RECEIVING WATER	HUC	NPDES PERMIT	INDUSTRY CLASSIFICATION	STATUS
WARSAW PWS UNITED WATER INDIAN	TIPPECANOE R VIA CENTER LAKE	05120106	IN0001678	WATER SUPPLY	INACTIVE
SUN METALS PRODUCTS, INC.	TIPPECANOE R VIA LOON CR UNNMD TRIB	05120106	IN0054640	PLATING AND POLISHING	ACTIVE
ZIMMER, INC. COPR OFFICE BLDG	TIPPECANOE R VIA WALNUT CR VIA SEWR	05120106	IN0056162	SURGICAL APPLIANCES & SUPPLIES	INACTIVE
SUBURBAN ACRES M.H.P.	TIPPECANOE RIVER	05120106	IN0025208	OPERATION OF RESIDENTIAL MOBILE HOME SITES	ACTIVE
WARSAW MUNICIPAL STP	TIPPECANOE R VIA BIG WALNUT CREEK9	05120106	IN0024805	SEWERAGE SYSTEMS	ACTIVE
MECKS WHISPERIN G PINES, INC.	TIPPECANOE RIVER	05120106	IN0054704	OPERATION OF RESIDENTIAL MOBILE HOME SITES	ACTIVE

10.0 WATERSHED LAND TREATMENT RECOMMENDATIONS

Center Lake/Lones Ditch Connection Channel

The historic flow paths of Center Lake have been changed dramatically. Center Lake was historically isolated from Pike Lake until the manmade connection occurred to Lones Ditch. This manmade connection to Lones Ditch has created an inflow of water, which carries additional pollution and sediment into Center Lake and has contributed to degraded water quality. The direct Center Lake tributary watershed is generally a small area immediately around the lake and including portions of Warsaw. However, because the manmade channels have been constructed to connect Pike Lake and Center Lake, a much larger tributary watershed influences the Center Lake water quality.

Center Lake now has a periodic flow of water that is coming from the Pike Lake (Lones Ditch) connection channel during low flow conditions. This flow of water carries with it the pollutant loading that currently exists in Pike Lake. Reference the Pike Lake IDNR diagnostic report, prepared by International Science & Technology, Inc. on January 9, 1991, for existing water quality information from this flow of water in addition to the water quality sampling performed by V3 in 2003.

The natural outlet from Center Lake was, and still is, the western channel to Walnut Creek. It is believed by some that groundwater (springs) was historically the main source of inflow to Center Lake. This belief is corroborated by observations of residents. A resident noted that flow at a low flow condition, due to lack of rainfall, caused Center Lake to be at such an elevation that water was flowing out to Walnut Creek and to the Lones Ditch connector channel at the same time.

A manually operated flow gate was installed in an earthen berm across the Lones Ditch connector channel to control the flow of water into Center Lake. Additionally, the connection to Walnut Creek has a concrete control structure with manual control gates to adjust water flow between Center Lake and Walnut Creek.

It is our recommendation that the flow gate to the Lones Ditch connector channel be closed at all times to prevent flow of water from Pike Lake into Center Lake. If flushing of this channel is desired by the Center Lake Association, it should only occur when the Center Lake water surface elevation is above the water elevation in the Lones Ditch connector channel. This will allow for water to flow out from Center Lake to the channel, and not allow pollutant inflow to occur.

We also recommend that an engineering feasibility study and final design grant be obtained from the IDNR LARE program to determine the appropriate 10-year flood elevation at the existing berm between Center Lake and the Lones Ditch connector and design the overflow connection. We recommend that the earth berm between the Pike Lake connector and Center Lake be set at an elevation equal to the 10-year storm elevation in the Tippecanoe River. The current conditions of Center Lake allow flood storage to occur within Center Lake for the Tippecanoe watershed. By blocking low flow into the lake and constructing a 10-year overflow berm, we believe that the first flush pollutant loads from the Tippecanoe River and Pike Lake will be prevented from entering Center Lake while preserving the Center Lake flood storage for flood waters of the Tippecanoe watershed.

The channel north of Center Lake may qualify under the new LARE dredging program. The two criteria that are being considered for this program would apply to this connection from the Lones Ditch to Center Lake. Funding should be sought to dredge the accumulated silt and sediment from this channel.

Walnut Creek Outlet Structure

The inflow of water from Walnut Creek is also carrying high levels of pollutants. In fact, the water chemistry data shows Walnut Creek as the worst potential pollutant inflow to Center Lake. This inflow should be prevented to the extent possible. The existing conditions of the connection between Center Lake and Walnut Creek has outflow to the creek during low flow. However, during storm flow and high water conditions, Walnut Creek flood waters backflow into Center Lake. This flow of Walnut Creek floodwaters should be prevented because it carries additional pollutants into Center Lake. The manual flow gate between Center Lake and Walnut Creek should be closed when it is obvious that stormwater is entering Center Lake at this location.

Operation policy for this structure should be adopted by the Center Lake Association Board to direct the appropriate actions for this flow gate structure. It is our understanding that the City of Warsaw owns this structure. It is necessary for the Center Lake Association and the City of Warsaw to come to an agreement for this operation plan and also implement this plan through City employees or Lake association volunteers.

We also recommend that this structure be included in the engineering feasibility study and final design grant to be obtained from the IDNR LARE program to determine the appropriate 10-year flood elevation at the existing berm between Center Lake and Walnut Creek and design this overflow connection. As recommended above for the Pike Lake connector, a 10-year overflow structure should be installed so that flood flows from Walnut Creek can utilize Center Lake for stormwater storage. This will prevent the Walnut Creek first flush pollutants from entering Center Lake but allow stormwater to access the available storage during high flow conditions.

Additionally, the outflow structure and Center Lake will need to be updated to accommodate the possible infestation of zebra mussels. Zebra mussels have entered the system, they were collected at both the Tippecanoe River and Lones Ditch sampling stations. It is only a matter of time before zebra mussels colonize the opening at the outfall structure and prevent manual manipulation of the gate.

Indiana Route 15 Storm Sewer

The storm sewer system from the Indiana State Route 15 is currently connected directly into Center Lake. This roadway is a state approved route for commercial tractor trailers. These commercial vehicles present the possibility of a catastrophic discharge of pollutants directly into Center Lake in the event of a gasoline spill, or other similar accident. Additionally, the maintenance procedures of the Indiana Department of Transportation includes a large amount of salt and sand to be placed on this roadway during the winter for control of snow and ice. This pollutant and sediment loading discharges directly into Center Lake.

It is recommended that a structural solution be implemented to filter the runoff that discharges to Center Lake. There are a variety of solutions that may be investigated for this problem including: vortex separator structures to remove sediment, trash, and oils from the stormwater runoff, sedimentation basins prior to discharge to the lake, connection of this storm sewer to a stormwater pump station which discharges downstream of Center Lake (Lones Ditch connector channel), or other feasible options. These alternatives should be examined and the most beneficial solution selected through a feasibility study that is funded by the IDNR LARE program. This study should be extended to review the discharge locations of the local storm sewer system to determine if there are means of providing filtration on these additional points of discharge.

No Parking Sign on Island

In a similar situation to the Indiana Route 15 storm sewer system mentioned above, the stormwater runoff from the roadway on Center Lake's island drains directly into the lake. When vehicles park on the island and roadway in order to access the lake for recreational fishing, it is creating a potential for contamination. The island roadway is utilized as more of a parking lot than a throughway. On repeated instances during wintertime ice-fishing activities, petroleum waste from an overabundance of vehicles has allowed a direct input of gas and oil into Center Lake. It is recommended that Center Lake Island be posted as No Parking, so that this potential point source pollution into the lake is eliminated.

Improving Mechanical Weed Harvesting Protocol

Currently, the cut aquatic plant material is being disposed on the shoreline of Center Lake. These disposal "piles" not only cause disturbance to important shoreline stabilizing vegetation, but also can easily reenter the water column following a rain event or a period of high water elevation, releasing the nutrients back into the water, which re-circulates the wasteload of nitrogen and phosphorus. One option is to consider an on-site disposal area that is not along the shoreline. This area might allow for periodic burning of the plant material with the necessary permits from the City of Warsaw. A second option is to identify a farmer that would be interested in spreading the cuttings over agricultural fields, utilizing the high nutrient content as fertilizer. The CLCA could enter an agreement for storage, hauling and spreading of the aquatic weed cuttings with such a person.

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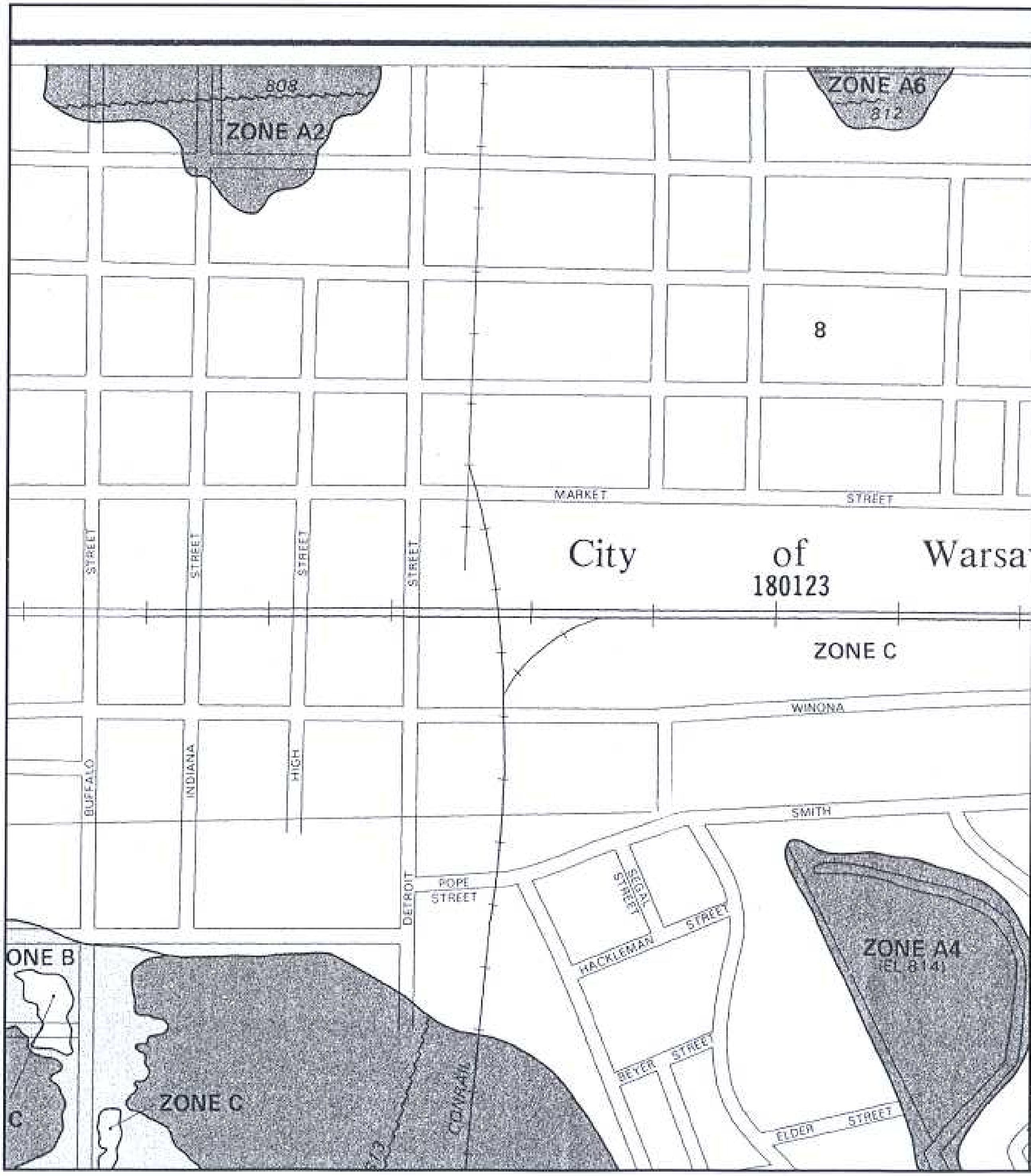
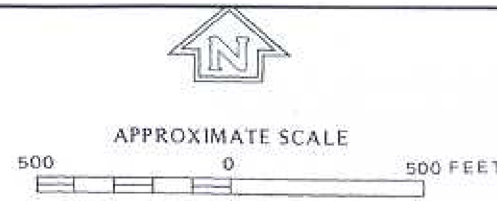
APPENDIX I:

FLOOD INSURANCE RATE MAPS - FLOODPLAIN





NATIONAL FLOOD INSURANCE PROGRAM

FIRM

FLOOD INSURANCE RATE MAP

KOSCIUSKO COUNTY,
INDIANA AND
INCORPORATED AREAS

PANEL 86 OF 150

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
WARSAW, CITY OF	180123	0086	C
WINONA LAKE, TOWN OF	180124	0086	[illegible]
UNINCORPORATED AREAS	180121	0086	[illegible]

18085C0086 C

EFFECTIVE DATE:
FEBRUARY 4, 1987

Federal Emergency Management Agency

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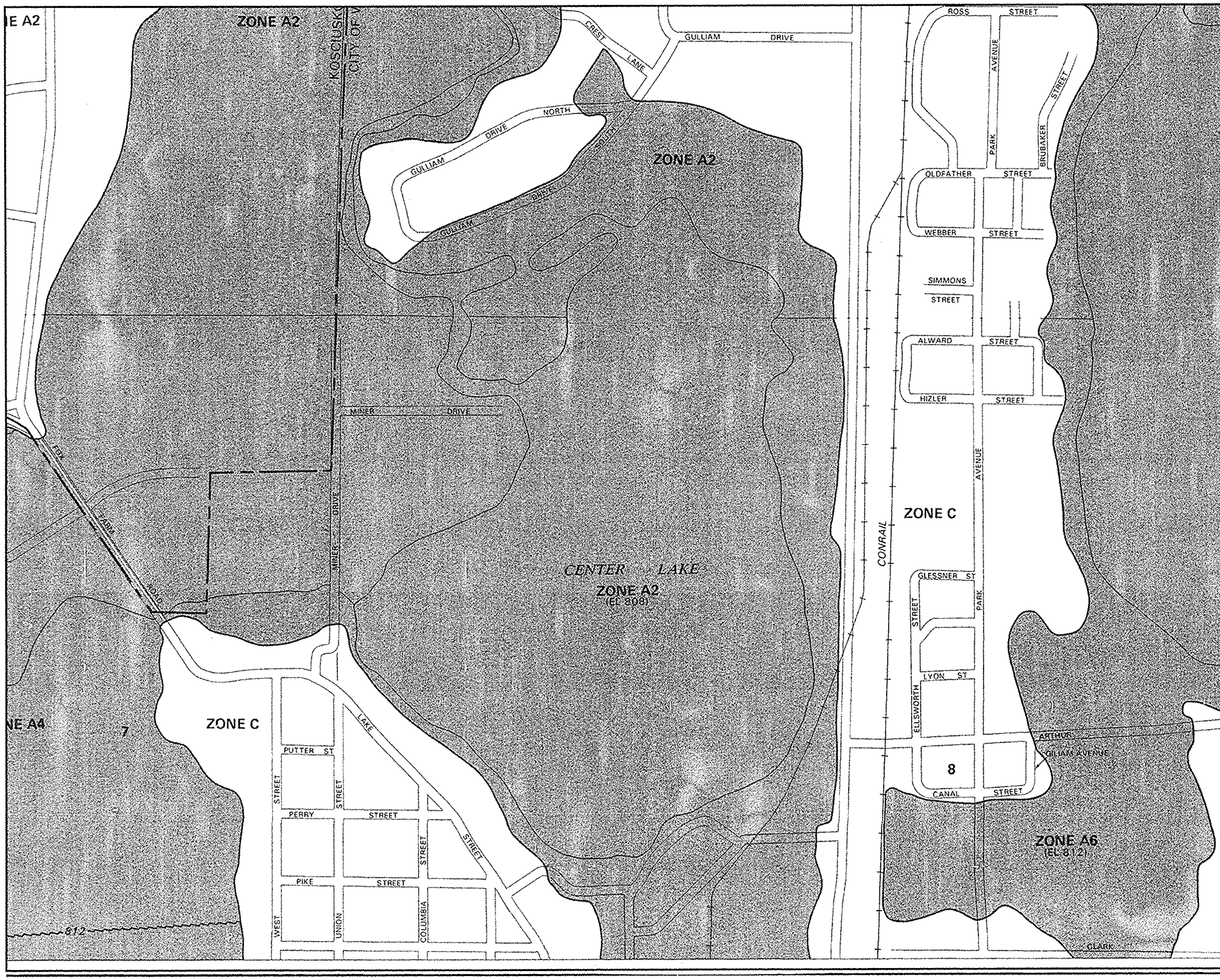

APPROXIMATE SCALE

500 0 500 FEET

NATIONAL FLOOD INSURANCE PROGRAM

FIRM

FLOOD INSURANCE RATE MAP

KOSCIUSKO COUNTY,
INDIANA AND
INCORPORATED AREAS

PANEL 78 OF 150

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
WARSAW, CITY OF	180123	0078	C
UNINCORPORATED AREAS	180121	0078	C

18085C0078 C

EFFECTIVE DATE:
FEBRUARY 4, 1987

Federal Emergency Management Agency

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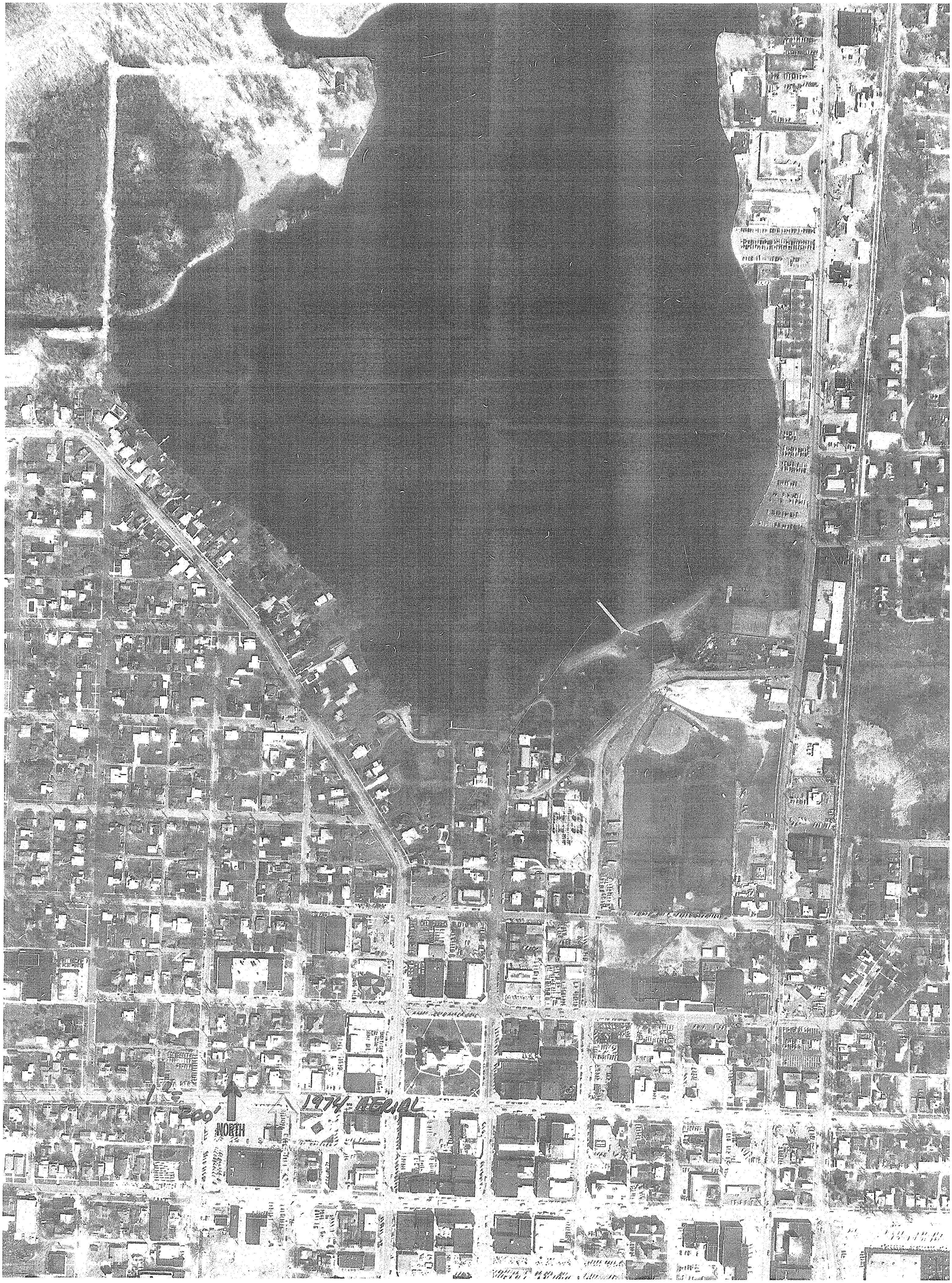
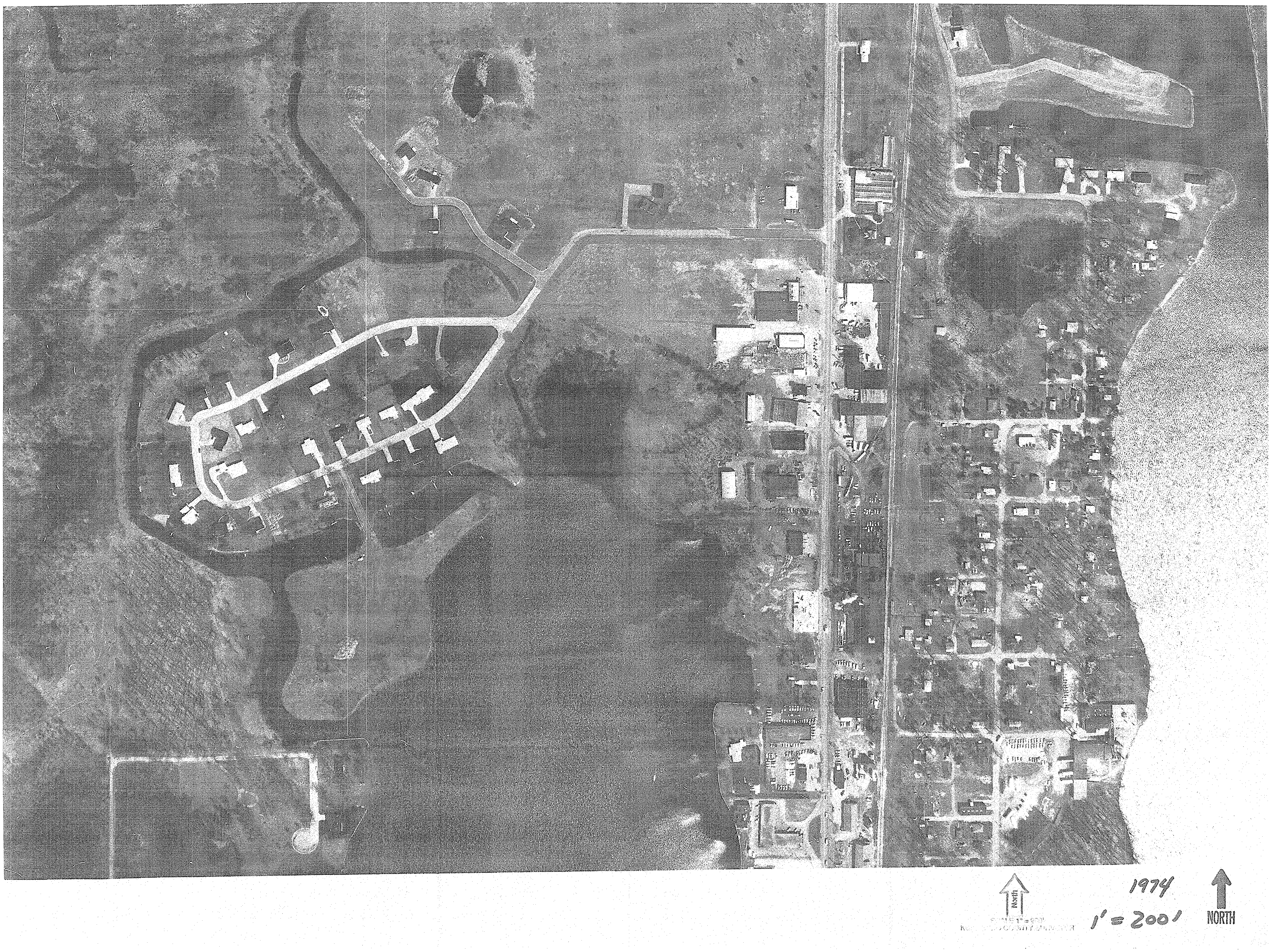
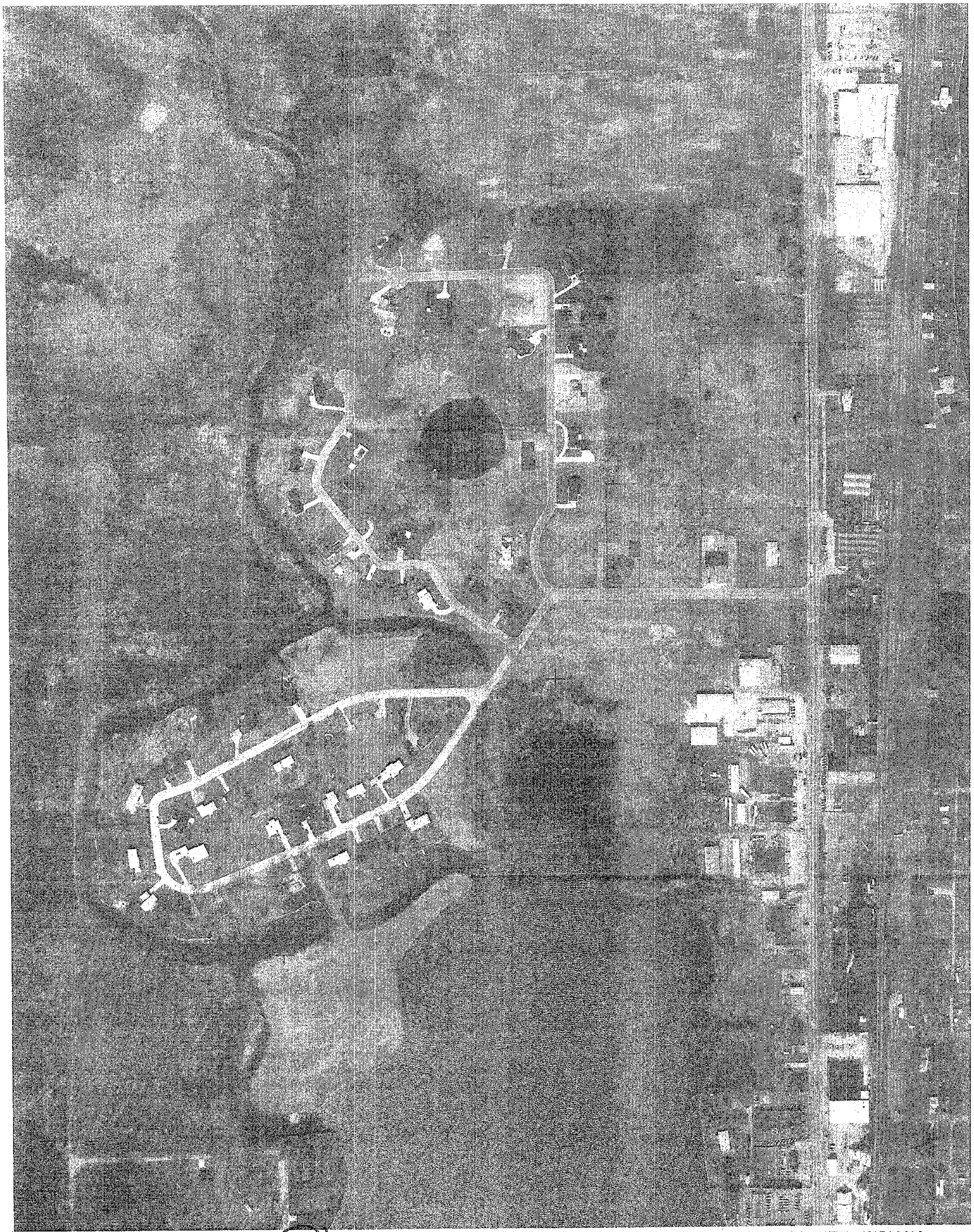
APPENDIX II:

AERIAL PHOTOS


1" = 200'
NORTH
1974 AERIAL


North
1974
1' = 200'
NORTH



AERIAL PHOTOGRAPHY FLOWN MARCH 26, 1985 THRU APRIL 17, 1985
BY SURDEX CORP. CHESTERFIELD, MO. FOR KOSCIUSKO COUNTY, INDIANA.

NORTH

KOSCIUSKO COUNTY, INDIANA
WAYNE TOWNSHIP
1" = 200'


NORTH
1" = 200'
1985

APPENDIX III:

THREATENED AND ENDANGERED SPECIES CORRESPONDENCE

DNR Indiana Department of Natural Resources

Joseph E. Kernan, Governor
John Goss, Director

Division of Nature Preserves
402 W. Washington St., Rm W267
Indianapolis IN 46204

January 12, 2004

Mr. Edward J. Belmonte
V3 Consultants
7325 Janes Avenue
Suite 100
Woodridge, IL 60517

Dear Mr. Belmonte:

I am responding to your request for information on the endangered, threatened, or rare (ETR) species, high quality natural communities, and natural areas documented from the Center Lake Study Area, Warsaw, Indiana. The Indiana Natural Heritage Data Center has been checked and enclosed you will find information on the ETR species and significant areas documented from the study area.

For more information on the animal species mentioned, please contact Katie Smith, Nongame Supervisor, Division of Fish and Wildlife, 402 W. Washington Room W273, Indianapolis, Indiana 46204, (317)232-4080.

The information I am providing does not preclude the requirement for further consultation with the U.S. Fish and Wildlife Service as required under Section 7 of the Endangered Species Act of 1973. You should contact the Service at their Bloomington, Indiana office.

U.S. Fish and Wildlife Service
620 South Walker St.
Bloomington, Indiana 47403-2121
(812)334-4261

At some point, you may need to contact the Department of Natural Resources' Environmental Review Coordinator so that other divisions within the department have the opportunity to review your proposal. For more information, please contact:

John Goss, Director
Department of Natural Resources
attn: Christie Kiefer
Environmental Coordinator
Division of Water
402 W. Washington Street, Room W264
Indianapolis, IN 46204
(317)232-4160

RECEIVED
JAN 15 2004
V3 COMPANIES

Please note that the Indiana Natural Heritage Data Center relies on the observations of many individuals for our data. In most cases, the information is not the result of comprehensive field surveys conducted at particular sites. Therefore, our statement that there are no documented significant natural features at a site should not be interpreted to mean that the site does not support special plants or animals.

Due to the dynamic nature and sensitivity of the data, this information should not be used for any project other than that for which it was originally intended. It may be necessary for you to request updated material from us in order to base your planning decisions on the most current information.

Thank you for contacting the Indiana Natural Heritage Data Center. You may reach me at (317)232-8059 if you have any questions or need additional information.

Sincerely,

Ronald P. Hellmich
Ronald P. Hellmich
Indiana Natural Heritage Data Center

enclosure: data sheet
invoice

***** Effective March 1, 2003, the Indiana Natural Heritage Data Center, Indiana Department of Natural Resources will be assessing a fee for information requests based on the time needed to complete the request. This charge will be $30 per one half hour, one half hour minimum. Most requests take one half hour or less to complete. An invoice for the amount due will be included with the completed request response.*

DNR Indiana Department of Natural Resources

Joseph E. Kernan, Governor
John Goss, Director

Division of Nature Preserves
402 W. Washington St., Rm W267
Indianapolis IN 46204

INVOICE

CLIENT: Mr. Edward J. Belmonte
V3 Consultants
7325 Janes Avenue
Suite 100
Woodridge, IL 60517

DATE OF SERVICES RENDERED: January 12, 2004

SERVICES RENDERED: Provided Indiana Natural Heritage Data Center data on endangered, threatened, or rare species, and high quality natural communities of Indiana documented from the Center Lake Study Area, Warsaw, Indiana.

INVOICE AMOUNT: $30.00

DATE: 1-12-2004

BY: Ronald P. Hellmich
Ronald P. Hellmich
FOR: Division of Nature Preserves
Indiana Department of Natural Resources
402 W. Washington St., Room W267
Indianapolis, IN 46204
(317)232-4052

Please make checks payable to Indiana Division of Nature Preserves.

Invoice payable upon receipt.

Send check to the attention of

Ronald P. Hellmich
Division of Nature Preserves

An Equal Opportunity Employer
Printed on Recycled Paper

January 12, 2004

ENDANGERED, THREATENED AND RARE SPECIES,
HIGH QUALITY NATURAL COMMUNITIES, AND SIGNIFICANT NATURAL AREAS DOCUMENTED
FROM THE CENTER LAKE STUDY AREA, WARSAW, INDIANA

TYPE	SPECIES NAME	COMMON NAME	STATE	FED	LOCATION	DATE	COMMENTS
ATWOOD							
Forest	FOREST - UPLAND MESIC	MESIC UPLAND FOREST	SG	**	T33NR06E 30 SEQ SWQ	NO D	
BURKET							
Mollusk	LIGUMIA RECTA	BLACK SANDSHELL	**	**	T32NR06E 06 SWQ SEQ SWQ	1992	WEATHERE SHELLS
Mollusk	PLEUROBEMA CLAVA	CLUBSHELL	SE	LE	T32NR06E 06 SWQ SEQ SWQ	1992	WEATHERE SHELLS
Mollusk	PTYCHOBRANCHUS FASCIOLARIS	KIDNEYSHELL	SSC	**	T32NR06E 06 SWQ SEQ SWQ	1992	WEATHERE SHELLS
Mollusk	VILLOSA FABALIS	RAYED BEAN	SSC	**	T32NR06E 06 SWQ SEQ SWQ	1992	WEATHERE SHELLS
LEESBURG							
Bird	ARDEA HERODIAS	GREAT BLUE HERON	**	**	T33NR06E 30 NEQ SEQ	1993	
Fish	AMMOCRYPTA PELLUCIDA	EASTERN SAND DARTER	SSC	**	T32NR06E 06 NWQ	1999	
Fish	COREGONUS ARTEDI	CISCO	SSC	**	T33NR06E 11 EH SEQ	1955	
Fish	HYBOPSIS AMBLOPS	BIGEYE CHUB	**	**	T33NR06E 14 NWQ SWQ	1991	
Fish	HYBOPSIS AMBLOPS	BIGEYE CHUB	**	**	T33NR06E 30 SH SEQ SEQ	1991	
Mollusk	ALASMIDONTA VIRIDIS	SLIPPERSHELL MUSSEL	**	**	T33NR06E 15 SEQ SEQ	1992	WEATHERE SHELLS
Mollusk	ALASMIDONTA VIRIDIS	SLIPPERSHELL MUSSEL	**	**	T33NR06E 21 SEQ SEQ NEQ & NEQ NEQ SEQ	1992	WEATHERE SHELLS
Mollusk	EPIOBLASMA OBLIQUATA	WHITE CAT'S PAW PEARLYMUSSEL	SE	LE	T33NR06E 15 SEQ SEQ	1992	WEATHERE SHELLS
Mollusk	EPIOBLASMA OBLIQUATA	WHITE CAT'S PAW PEARLYMUSSEL	SE	LE	T33NR06E 30 SH SEQ SEQ	1991	WEATHERE SHELLS
Mollusk	EPIOBLASMA TORULOSA RANGIANA	NORTHERN RIFFLESHELL	SE	LE	T33NR06E 14 SWQ	1987	WEATHERE SHELLS
Mollusk	EPIOBLASMA TORULOSA RANGIANA	NORTHERN RIFFLESHELL	SE	LE	T33NR06E 30 SEQ	1987	WEATHERE SHELLS
Mollusk	EPIOBLASMA TORULOSA RANGIANA	NORTHERN RIFFLESHELL	SE	LE	T33NR06E 14 SWQ NEQ NEQ	1992	WEATHERE SHELLS
Mollusk	EPIOBLASMA TORULOSA RANGIANA	NORTHERN RIFFLESHELL	SE	LE	T33NR06E 15 SEQ SEQ	1992	WEATHERE SHELLS
Mollusk	EPIOBLASMA TORULOSA RANGIANA	NORTHERN RIFFLESHELL	SE	LE	T33NR06E 21 SEQ SEQ NEQ & NEQ NEQ SEQ	1992	WEATHERE SHELLS
Mollusk	LAMPSILIS FASCIOLA	WAVYRAYED LAMPMUSSEL	SSC	**	T33NR06E 14 NWQ SWQ	1991	LIVE

STATE: SX=extirpated, SE=endangered, ST=threatened, SR=rare, SSC=special concern, WL=watch list, SG=significant,** no status but rarity warrants concern
FEDERAL: LE=endangered, LT=threatened, LELT=different listings for specific ranges of species, PE=proposed endangered, PT=proposed threatened, ESA=appearance similar to LE species,**=not listed

ENDANGERED, THREATENED AND RARE SPECIES,
HIGH QUALITY NATURAL COMMUNITIES, AND SIGNIFICANT NATURAL AREAS DOCUMENTED
FROM THE CENTER LAKE STUDY AREA, WARSAW, INDIANA

TYPE	SPECIES NAME	COMMON NAME	STATE	FED	LOCATION	DATE	COMMENTS
Mollusk	LAMPSILIS FASCIOLA	WAVYRAYED LAMPMUSSEL	SSC	**	T33NR06E 30 SH SEQ SEQ	1991	LIVE
Mollusk	LAMPSILIS FASCIOLA	WAVYRAYED LAMPMUSSEL	SSC	**	T33NR06E 14 SWQ NEQ NEQ	1992	LIVE
Mollusk	LAMPSILIS FASCIOLA	WAVYRAYED LAMPMUSSEL	SSC	**	T33NR06E 15 SEQ SEQ	1992	LIVE
Mollusk	LAMPSILIS FASCIOLA	WAVYRAYED LAMPMUSSEL	SSC	**	T33NR06E 21 SEQ SEQ NEQ & NEQ NEQ SEQ	1992	FRESH DEA
Mollusk	LIGUMIA RECTA	BLACK SANDSHELL	**	**	T33NR06E 30 SH SEQ SEQ	1991	WEATHERE SHELLS
Mollusk	LIGUMIA RECTA	BLACK SANDSHELL	**	**	T33NR06E 14 SWQ NEQ NEQ	1992	WEATHERE SHELLS
Mollusk	LIGUMIA RECTA	BLACK SANDSHELL	**	**	T33NR06E 15 SEQ SEQ	1992	WEATHERE SHELLS
Mollusk	PLEUROBEMA CLAVA	CLUBSHELL	SE	LE	T33NR06E 30 SH SEQ SEQ	1991	LIVE
Mollusk	PLEUROBEMA CLAVA	CLUBSHELL	SE	LE	T33NR06E 14 NWQ SWQ	1991	LIVE
Mollusk	PLEUROBEMA CLAVA	CLUBSHELL	SE	LE	T33NR06E 14 SWQ NEQ NEQ	1992	FRESH DEA
Mollusk	PLEUROBEMA CLAVA	CLUBSHELL	SE	LE	T33NR06E 15 SEQ SEQ	1992	LIVE
Mollusk	PLEUROBEMA CLAVA	CLUBSHELL	SE	LE	T33NR06E 21 SEQ SEQ NEQ & NEQ NEQ SEQ	1992	LIVE
Mollusk	PTYCHOBRANCHUS FASCIOLARIS	KIDNEYSHELL	SSC	**	T33NR06E 14 NWQ SWQ	1991	LIVE
Mollusk	PTYCHOBRANCHUS FASCIOLARIS	KIDNEYSHELL	SSC	**	T33NR06E 30 SH SEQ SEQ	1991	LIVE
Mollusk	PTYCHOBRANCHUS FASCIOLARIS	KIDNEYSHELL	SSC	**	T33NR06E 14 SWQ NEQ NEQ	1992	LIVE
Mollusk	PTYCHOBRANCHUS FASCIOLARIS	KIDNEYSHELL	SSC	**	T33NR06E 15 SEQ SEQ	1992	LIVE
Mollusk	PTYCHOBRANCHUS FASCIOLARIS	KIDNEYSHELL	SSC	**	T33NR06E 21 SEQ SEQ NEQ & NEQ NEQ SEQ	1992	LIVE
Mollusk	TOXOLASMA LIVIDUS	PURPLE LILLIPUT	SSC	**	T33NR06E 14 NWQ SWQ	1991	LIVE
Mollusk	TOXOLASMA LIVIDUS	PURPLE LILLIPUT	SSC	**	T33NR06E 30 SEQ	1987	FRESH DEA
Mollusk	TOXOLASMA LIVIDUS	PURPLE LILLIPUT	SSC	**	T33NR06E 14 SWQ NEQ NEQ	1992	FRESH DEA
Mollusk	TOXOLASMA LIVIDUS	PURPLE LILLIPUT	SSC	**	T33NR06E 15 SEQ SEQ	1992	LIVE
Mollusk	TOXOLASMA LIVIDUS	PURPLE LILLIPUT	SSC	**	T33NR06E 21 SEQ SEQ NEQ & NEQ NEQ SEQ	1992	LIVE
Mollusk	TOXOLASMA PARVUM	LILLIPUT	**	**	T33NR06E 14 SWQ NEQ NEQ	1992	LIVE
Mollusk	TOXOLASMA PARVUM	LILLIPUT	**	**	T33NR06E 14 NWQ SWQ	1991	FRESH DEA

STATE: SX=extirpated, SE=endangered, ST=threatened, SR=rare, SSC=special concern, WL=watch list, SG=significant,** no status but rarity warrants concern
FEDERAL: LE=endangered, LT=threatened, LELT=different listings for specific ranges of species, PE=proposed endangered, PT=proposed threatened, ESA=appearance similar to LE species,**=not listed

ENDANGERED, THREATENED AND RARE SPECIES,
HIGH QUALITY NATURAL COMMUNITIES, AND SIGNIFICANT NATURAL AREAS DOCUMENTED
FROM THE CENTER LAKE STUDY AREA, WARSAW, INDIANA

TYPE	SPECIES NAME	COMMON NAME	STATE	FED	LOCATION	DATE	COMMENTS
Reptile	CLEMMYS GUTTATA	SPOTTED TURTLE	SE	**	T33NR06E 19 SEQ NEQ SEQ	1987	
Reptile	EMYDOIDEA BLANDINGII	BLANDING'S TURTLE	SE	**	T33NR06E 31 NEQ SEQ	1998	
Vascular Plant	ANDROMEDA GLAUCOPHYLLA	BOG ROSEMARY	SR	**	T33NR06E 16 & 17	1916	
Vascular Plant	CAREX CHORDORRHIZA	CREEPING SEDGE	SE	**	T33NR06E 16	1912	
Vascular Plant	CAREX ECHINATA	LITTLE PRICKLY SEDGE	SE	**	T33NR06E 16	1920	
Vascular Plant	CORNUS CANADENSIS	BUNCHBERRY	SE	**	T33NR06E 16	1905	
Vascular Plant	DROSERA INTERMEDIA	SPOON-LEAVED SUNDEW	SR	**	T33NR06E 16	1905	
Vascular Plant	MALAXIS UNIFOLIA	GREEN ADDER'S-MOUTH	SE	**	T33NR06E 16	1916	
Vascular Plant	PANICUM BOREALE	NORTHERN WITCHGRASS	SR	**	T33NR06E 16	1926	
Vascular Plant	PLATANTHERA PSYCODES	SMALL PURPLE-FRINGE ORCHIS	SR	**	T33NR06E 20 SEQ SEQ SEQ	1986	
Vascular Plant	POTAMOGETON STRICTIFOLIUS	STRAIGHT-LEAF PONDWEED	SE	**	T33NR06E 11 & 12	1930	
Wetland	WETLAND - BOG CIRCUMNEUTRAL	CIRCUMNEUTRAL BOG	SG	**	T33NR06E 19 NEQ SEQ	1982	

WARSAW

TYPE	SPECIES NAME	COMMON NAME	STATE	FED	LOCATION	DATE	COMMENTS
Vascular Plant	LEMNA PERPUSILLA	MINUTE DUCKWEED	SX	**	T32NR06E 19	1932	

STATE: SX=extirpated, SE=endangered, ST=threatened, SR=rare, SSC=special concern, WL=watch list, SG=significant,** no status but rarity warrants concern
FEDERAL: LE=endangered, LT=threatened, LELT=different listings for specific ranges of species, PE=proposed endangered, PT=proposed threatened, ESA=appearance similar to LE species,**=not listed

United States Department of the Interior
Fish and Wildlife Service

Bloomington Field Office (ES)
620 South Walker Street
Bloomington, IN 47403-2121
Phone: (812) 334-4261 Fax: (812) 334-4273

January 28, 2004

Mr. Edward J. Belmonte
V3 Consultants
7325 James Avenue, Suite 100
Woodridge, Illinois 60517

Project No.:	02218
Project:	Center Lake Diagnostic Study
Waterway:	Center Lake, Tippecanoe River, Walnut Creek, Lones Ditch, Tippecanoe River-Center Lake Diversion Canal
Location:	Warsaw, Kosciusko County

Dear Mr. Belmonte:

This responds to your letter dated January 7, 2004 , requesting our comments on the aforementioned project.

These comments have been prepared under the authority of the Fish and Wildlife Coordination Act (16 U.S.C. 661 et. seq.) and are consistent with the intent of the National Environmental Policy Act of 1969, the Endangered Species Act of 1973, and the U. S. Fish and Wildlife Service's Mitigation Policy.

ENDANGERED SPECIES

The proposed project is within the range of the Federally endangered Indiana bat (Myotis sodalis) and clubshell mussel (Pleurobema clava) and the threatened bald eagle (Haliaeetus leucocephalus) and northern copperbelly water snake (Nerodia erythrogaster neglecta). It is also within the range of the eastern massasauga rattlesnake (Sistrurus catenatus catenatus), which has been listed as a Candidate for possible future listing as either threatened or endangered. Candidate species are those for which sufficient information on their biological status exists to warrant listing, but for which listing has not yet occurred.

Indiana bats have been found along Deeds Creek in Kosciusko County. This creek is upstream of Pike Lake, and both the creek and lake drain to the Tippecanoe River through Lones Ditch. There is suitable summer maternity habitat for the Indiana bat along most of the Tippecanoe River and the un-urbanized section of Walnut Creek within the Study Location depicted on your project location map. This potential habitat includes both riparian and adjacent upland woodlands. We do not have data on the status of the Indiana bat within these specific habitats because no surveys have been conducted here for this species. However, the U.S. Fish and Wildlife Service considers this species to be present in suitable summer habitat throughout Indiana unless proven otherwise through mist-net surveys.

The clubshell mussel is found in the Tippecanoe River within the Study Location depicted on you project location map. The Tippecanoe River contains the largest remaining population of the clubshell in the world, with the greatest numbers being found in the upper Tippecanoe River in Kosciusko, Marshall, and a small portion of Fulton Counties. The section of the river upstream from Warsaw, within your Study Location, is thought to contain the largest portion of the reproducing population of this species in the Tippecanoe River, although it is known to be reproducing at several other sites downstream from Warsaw. The river is therefore critical to the recovery of the endangered clubshell mussel. The Tippecanoe River also supports 11 Indiana endangered mussel species, several of which are federal Species at Risk which may eventually become federally listed as either threatened or endangered if habitat loss is not reversed.

Bald eagles are occasionally found at Kosciusko County lakes and rivers, particularly during winter. The closest known nesting bald eagles are along the lower Tippecanoe River near the Wabash River and along the Wabash River near Logansport. They may eventually reach Kosciusko County as nesters. The northern copperbelly water snake is known from wetlands at Tippecanoe Lake and is not likely to be present along the river within the Study Location.

The eastern massasauga is known from several locations in Kosciusko County and has been reported along the river north of Warsaw in the past, within your Study Location. The current status here is unknown. Surveys for this species may be necessary as part of this project if suitable habitats are likely to be impacted.

These endangered species comments constitute informal consultation only. They do not fulfill the requirements of Section 7 of the Endangered Species Act of 1973, as amended.

The Tippecanoe River is nationally recognized for its unique biological diversity and natural condition, particularly concerning freshwater mussels and fishes. Recently, The Nature Conservancy (TNC) ranked the Tippecanoe River as the eighth most important river in the entire country for preserving imperiled aquatic species. TNC has since opened the Tippecanoe River Project Office in Winamac, Indiana, to work with landowners in the watershed to protect and reforest riparian habitats (Enclosure No. 1).

The Indiana Department of Natural Resources owns a 25 acre Wetland Conservation Area near Center Lake, as shown on Enclosure No. 2. Also, there is a major great blue heron rookery along the Tippecanoe River north of US 30 within your Study Location. This is the oldest known heron rookery in Indiana, with almost 170 years of documented use. For information on both of these important sites, please contact the Indiana Division of Fish and Wildlife.

We appreciate the opportunity to comment at this early stage of project planning. Please keep us informed of project plans as they progress. If you have any questions, please contact Elizabeth McCloskey at (219) 983-9753 or elizabeth_mccloskey@fws.gov.

Sincerely yours,

Elizabeth S. McCloskey
Acting

for Scott E. Pruitt
Supervisor

cc: Christie Kiefer, Environmental Coordinator, Division of Water, Indianapolis, IN

The Nature Conservancy®
INDIANA CHAPTER
Saving the Last Great Places

THE NATURE CONSERVANCY

Tippecanoe River Project

LOCATION

The Tippecanoe River twists and turns for 225 miles throughout northern Indiana on its 70-mile trek from Lake Tippecanoe to the Wabash River just north of Lafayette, Indiana.

DESCRIPTION

The Tippecanoe River's name is derived from village of Miami and Shawnee Indians known as "Kithtippecanunk." This name translates in English to "a place of the buffalo fish."

Very few streams in the upper Midwest can come close to matching the numbers of imperiled species, or the overall species diversity that the Tippecanoe supports.

The Tippecanoe River watershed encompasses 1.25 million acres, spanning 14 counties in Indiana. There is a small wooded riparian area throughout the river's run; the floodplain areas are largely agricultural with some development.

IMPORTANCE

A 1998 study "Rivers of Life, *Critical Watersheds for Protecting Freshwater Diversity*" ranked the Tippecanoe as the eighth most important river in the *entire country* for preserving imperiled aquatic species. The river supports 21 species of fish and mussels that are considered to be "at risk", and 6 fish and mussel species that hold Federally Endangered status.

SPECIES SPOTLIGHT

A recent one-season study turned up over 70 species, including the Tippecanoe Darter, bluebreast darter and gilt darter—three small state endangered fish that are indicators of great water quality.

Past studies have found evidence of five federally endangered mussel species: the Clubshell, Northern Riffelshell, White Catspaw, Fanshell, and Rough Pigtoe. The Tippecanoe seems to have retained the bulk of its original fish and mussel communities.

PROJECT GOALS

- Establishment of a citizen advisory committee to help guide the project
- Create awareness of the river as a resource with national significance
- Work with private landowners to make environmentally sound land use changes and decisions

ENCLOSURE NO. 1.

- Development of a comprehensive bio-sampling program: fish, mussels, and invertebrates
- Orchestrate other groups and agencies in the watershed

POTENTIAL THREATS

- Soil erosion and sedimentation: agricultural and urban
- Chemical and nutrient runoff
- Water use / Budget issues
- Failing / inadequate septic systems
- Urban / industrial pollution and runoff
- Loss of riparian habitat; stream corridor development
- Stream use issues; i.e. drainage ditches vs. natural habitat
- Lack of "refuge habitat" for species repopulation in the event of disaster
- Loss of wetlands and wetland habitat

PROTECTION EFFORTS

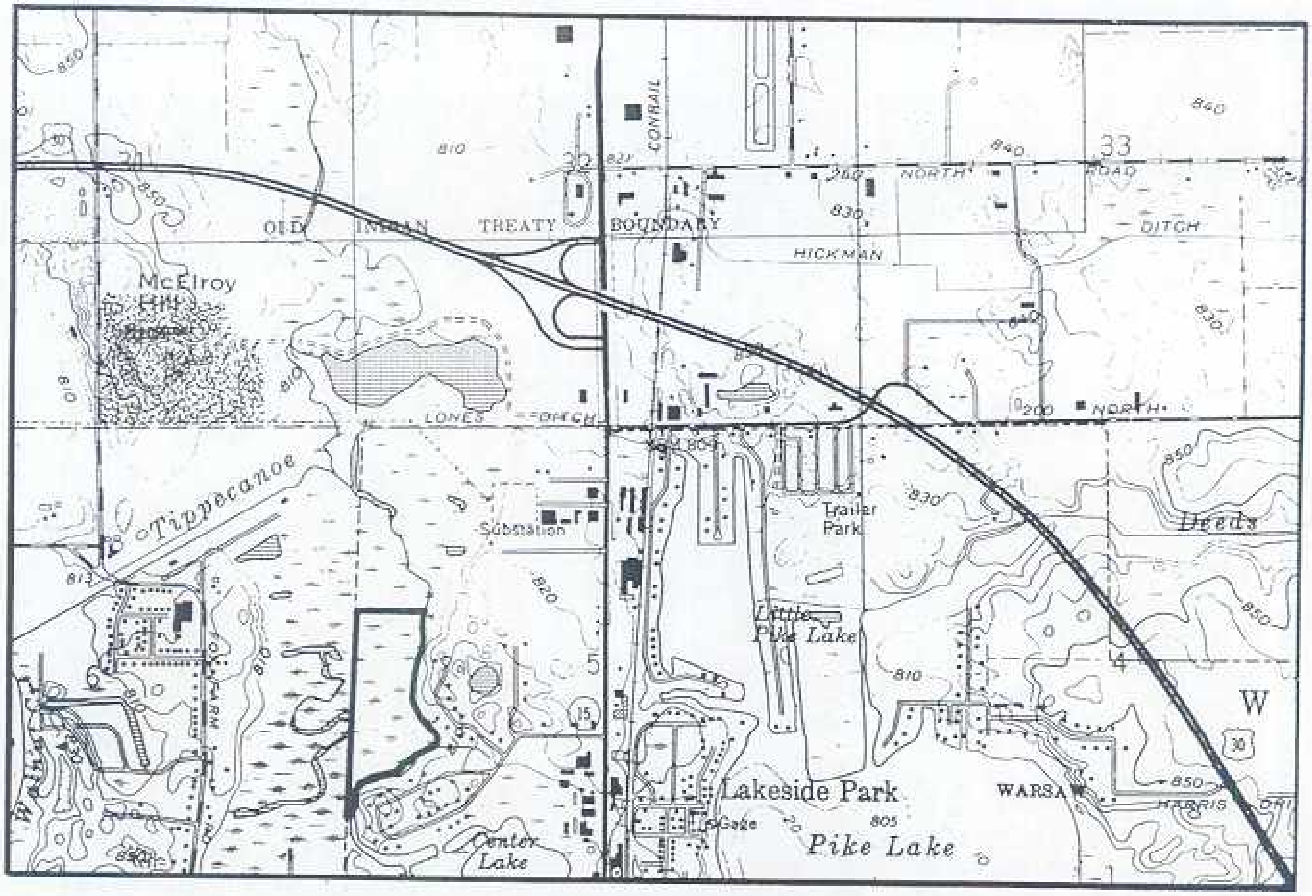
- The Tippecanoe River Project Office, opened in October of 2000, will initially focus its efforts on the upper 1/3 of the river, specifically the critical areas that have the potential to degrade water quality and habitat.

- In the spring of 2001 we will be doing a study of the fish, insect and mussel species present at seven locations from Winamac to Lake Tippecanoe to determine where best to focus our efforts to protect the target species. This study will also help us to identify any potential threats to the species that we can devise strategies for their abatement. This will be done periodically in order for us to determine what kind of impact we are having on the species we are trying to protect. This will help us to gauge the success of our efforts and determine whether or not we are on the right course.

- The Nature Conservancy, through the Tippecanoe River Project Office, will be offering funds for needed conservation practices on land that lies within a reasonable proximity to the river corridor. The practices that we will be focusing on will include, but will not be limited to: tree plantings, grassed buffers and filter strips, forested riparian buffer strips, wind breaks, and many other "on the land" practices that will help to conserve the land and prevent sediment and other contaminants from entering the river from the surrounding lands. Other practices may include fencing livestock out of the river and its tributaries, conservation plantings, reduced tillage and no-till adoption for farmers, and many other similar practices.

The Conservancy also has the ability to partner with existing USDA programs to help make land-based conservation practices affordable for landowners in the watershed. We are primarily interested in the conservation practices that will help protect the land by reducing soil erosion while helping to protect water quality.

Contact: Chad Watts
574-946-7491
cwatts@tnc.org



CENTER LAKE

Wetland Conservation Area: 25 acres in Warsaw, Kosciusko County

Location and Access: This area lies on the west side of the Tippecanoe River — Center Lake Diversion Canal. Access is from Union Street on the southwest side of Warsaw.

Description: Property is mixed upland and wetland floodplain. Dogwood, marsh grasses and cattails make the area a haven for wildlife. The property often floods when the Tippecanoe River rises a few feet.

Wildlife Usage: Deer, mink, rabbit and raccoon use the area. Many species of wetland birds including woodcock and marsh wren use the area.

Permitted Uses: Hunting is NOT permitted as the area is in Warsaw city limits. Trapping is permitted within state seasons. Also permitted are hiking, nature study and berry picking.

Contact: Indiana Division of Fish and Wildlife
402 West Washington, Room W273
Indianapolis, Indiana 46204
317-232-4080

ENCLOSURE NO. 2.

APPENDIX IV:

LABORATORY RESULTS

Environmental Health Laboratories
The Nation's Drinking Water Laboratory
Division of Underwriters Laboratories Inc.

110 South Hill Street
South Bend, IN 46617
Phone: (574) 233-4777
Fax: (574) 233-8207

LABORATORY REPORT

This report contains 8 pages.
(including the cover page)

If you have any questions concerning this report, please do not hesitate to call us at 1-800-332-4345 or 574-233-4777.

This report may not be reproduced, except in full, without written approval from Environmental Health Laboratories (EHL). EHL is accredited by the National Environmental Laboratory Accreditation Program (NELAP).

A Division of Underwriters Laboratories Inc.

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QUALITY ETHICS SERVICE

Glossary of Terms

LMB	Laboratory Method Blank: a sample of laboratory reagent water which is prepared and analyzed as a sample.
LFB	Laboratory Fortified Blank: a sample of laboratory reagent water to which the analytes of interest are added at a known concentration.
TB	Trip Blank: a sample of reagent water which is shipped to the field and used to monitor for contamination during sample collection.
MS	Matrix Spike: a field sample to which the analytes of interest are added at a known concentration.
MSD	Matrix Spike Duplicate
QCS	Quality Control Sample: a sample of laboratory reagent water to which the analytes of interest are added at a known concentration. The difference between the LFB and QCS is that the analytes solutions which are added to the QCS are obtained from a separate vendor than those added to the LFB or used for the CCC.
CCC	Continuing Calibration Check: a standard used to assure that the analytical instrument is properly calibrated.
SS	Surrogate Standards: these are compounds which are different than the analytes of interest but which have similar chemical properties. For certain methods these are added to samples and are used to monitor analytical accuracy.
IS	Internal Standard: these compounds are added to samples or extracts depending upon the method. They are used in certain methods to calculate the concentrations of the analytes of interest. The internal standards are different from the analytes of interest but have similar chemical properties.

Environmental Health Laboratories
The Nation's Drinking Water Laboratory

110 S. Hill Street
South Bend, IN 46617
574.233.4777
800.332.4345
Fax: 574.233.8207
www.ehl.cc

LABORATORY REPORT

Client: V-3 Consultants
Attn: Ed Belmonte
7325 Janes Avenue
Suite 100
Woodridge, IL 60517

Report#: 931134-52

Priority: Standard Written

Status: Final

Project/Site: Center Lake / Multiple

Samples Submitted: Nineteen surface water samples

Copies to: None

Collected: 08/20/03 By: Client Received: 08/20/03

REPORT SUMMARY

Nineteen surface water samples were submitted for multiple parameter analyses.

Note: Total Kjeldahl nitrogen (TKN) analysis performed by Sherry Laboratories, Columbus, IN.

Detailed quantitative results are presented on the following pages.

We appreciate the opportunity to provide you with this analysis. If you have any questions concerning this report, please do not hesitate to call us at (574) 233-4777.

Note: This report may not be reproduced, except in full, without written approval from Environmental Health Laboratories (EHL). EHL is accredited by the National Environmental Laboratory Accreditation Program (NELAP). This report satisfies the requirements of your project but has not been prepared to comply with NELAP reporting requirements.

REVIEWED BY: [signature] Reporter DATE: 9/8/03

FINALIZED BY: Matt Hug[?] Project Manager DATE: 9-8-03

A Division of Underwriters Laboratories Inc.

NITROGEN, AMMONIA—Surface Water

Lab #	Site Description	MRL		Results	
931138	V3-CLB	0.1		**2.1**	**mg/L**
931144	V3-CLS	0.1	<	0.1	mg/L
931150	V3-PL	0.1	<	0.1	mg/L

Analyzed: 08/21/03 Analyst: EE Method #: 4500-NH_3 D

NITROGEN, NITRATE—Surface Water

Lab #	Site Description	MCL	MRL	Results (mg/L)	
931134	V3-CLB	10	0.1	<	0.1
931140	V3-CLS	10	0.1	<	0.1
931146	V3-PL	10	0.1		**0.2**

Analyzed: 08/21/03 Analyst: KS Method: 353.2

NITROGEN, NITRITE—Surface Water

Lab #	Site Description	MCL	MRL	Results (mg/L)	
931135	V3-CLB	1	0.01	<	0.01
931141	V3-CLS	1	0.01	<	0.01
931147	V3-PL	1	0.01		**0.03**

Analyzed: 08/21/03 Analyst: KS Method: 353.2

PHOSPHORUS, DISSOLVED—Surface Water

Lab #	Site Description	MRL	Results (mg P/L)	
931136	V3-CLB	0.05		**0.34**
931142	V3-CLS	0.05	<	0.05
931148	V3-PL	0.05		**0.06**

Analyzed: 08/26/03 Analyst: KS Method: 4500-P E

Client: V-3 Consultants

Report#: 931134-52

PHOSPHORUS, TOTAL—Surface Water

Lab #	Site Description	MRL		Results (mg P/L)
931137	V3-CLB	0.05		**0.46**
931143	V3-CLS	0.05	<	0.05
931149	V3-PL	0.05		**0.09**

Analyzed: 08/26/03 Analyst: KS Method: 4500-P E

FECAL COLIFORM —Surface Water

Lab #	Site Description	Limit	Results (cfu/100mL)
931152	V3-PL	200	**45**

Analyzed: 08/21/03 Analyst: AC Method: SM 9222-D

NITROGEN, TOTAL KJELDAHL—Surface Water

Lab #	Site Description	MRL		Results	
931139	V3-CLB	1.0		**3.3**	**ppm**
931145	V3-CLS	1.0	<	1.0	ppm
931151	V3-PL	1.0		**1.0**	**ppm**

Analyzed: 09/05/03 Analyst: Reference Lab Method #: 351.2

REFERENCES AND DEFINITIONS OF TERMS

General Chemistry

References: 1. EPA-600/4-79-020
Methods for Chemical Analysis of Water and Wastes
2. Standard Methods For the Examination of Water and Wastewater
Vol. 19, 1995

Fecal Coliform

Analytical technique: Membrane Filtration
Reference: Standard Methods For Examination of Water and Wastewater
Vol. 19, 1995

MCL = (Maximum Contaminant Levels) are the maximum allowable concentrations of regulated parameters in public drinking water supplies. Monitoring requirements for public supplies are not currently applicable to private (residential) water systems.

MRL = EHL's Minimum Reporting Limit

< = "less than." This number is the lowest reportable value by the procedure used for analysis.

√ = If dilutions were required for quantitation of specific parameters, they are indicated by a (√) preceding the result.

1 mg/L = 1 milligram per liter = 1 part per million (ppm)

1 cfu = 1 Colony Forming Unit = a bacteria colony presumed to have originated from a single bacterium present in the sample.

Environmental Health Laboratories
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ORDER # 87516

SHADED AREA FOR LAB USE ONLY

CHAIN OF CUSTODY RECORD

PAGE ____ OF ____

CLIENT/COMPANY ORDERING TEST: V3 Consultants

SAMPLER (Signature):

STATE (of Sample Origin): | PWS ID#: | PROJECT NAME: | PO#:

POPULATION SERVED: | SOURCE WATER:

COMPLIANCE MONITORING? YES NO

EHL LAB #	COLLECTION DATE	COLLECTION TIME	AM/PM	SAMPLING SITE	TEST NAME	SAMPLE REMARKS	Chlorinated Yes	Chlorinated No	# OF CONTAINERS	MATRIX CODE	TURNAROUND TIME
9301134	8-20	1225	AM PM	V3 - CLB	Nitrate - 353.2						
9301135			AM PM		NO2						
9301136			AM PM		Dis Phos						
9301137			AM PM		T Phos	pH<2					
9301138			AM PM		Ammonia	pH<2					
9301139			AM PM		TKN	pH<2					
9301140		1240	AM PM	V3- CLS	Nitrate - 353.2						
9301141			AM PM		NO2						
931142			AM PM		Dis Phos						
931143			AM PM		T Phos	pH<2					
931144			AM PM		Ammonia	pH<2					
931145			AM PM		TKN	pH<2					
			AM PM								

FIELD COMMENTS: CARRIER ____ AIRBILL NO. ____ COOLER NO. ____ DATE SHIPPED ____

RELINQUISHED BY: (Signature)	DATE	TIME	RECEIVED BY: (Signature)	DATE	TIME
		AM PM			AM PM
		AM PM			AM PM
		AM PM	RECEIVED FOR LABORATORY BY: Amastis	8-20-03	1700 AM PM

LAB RESERVES THE RIGHT TO RETURN UNUSED PORTIONS OF NON-AQUEOUS SAMPLES TO CLIENT.

LAB COMMENTS
In house COC

CONDITIONS UPON RECEIPT: (Check One) wet X ☐ Iced ☐ Ambient or ____ °C Upon Receipt

MATRIX CODES:

TURN-AROUND TIME (TAT) - SURCHARGES

SW = STANDARD WRITTEN (15 WORKING DAYS) 0%
RV* = RUSH (5 WORKING DAYS) VERBAL 50%
RW* = RUSH (5 WORKING DAYS) WRITTEN 75%
*-Please Call, Expedited services not available for all services.

IV* = IMMEDIATE (3 WORKING DAYS) VERBAL 100%
IW* = IMMEDIATE (3 WORKING DAYS) WRITTEN 125%
SP* = WEEKEND, HOLIDAY Call

STAT* = LESS THAN 48 HOURS Call
Samples received unannounced with less than 48 hours holding time remaining may be subject to additional surcharges.

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CHAIN OF CUSTODY RECORD

PAGE ______ OF ______

CLIENT/COMPANY ORDERING TEST	SAMPLER (Signature)	STATE (of Sample Origin)	PWS ID#	PROJECT NAME	PO#
V3 Consultants					
COMPLIANCE MONITORING? YES NO		POPULATION SERVED:	SOURCE WATER:		

EHL LAB#	COLLECTION DATE	COLLECTION TIME		SAMPLING SITE	TEST NAME	SAMPLE REMARKS	Chlorinated Yes	Chlorinated No	# OF CONTAINERS	MATRIX CODE	TURNAROUND TIME
931146	8-20	1510	AM PM	V3 - PL	Nitrate - 353.2				1		
931147			AM PM		NO2						
931148			AM PM		Dis Phos						
931149			AM PM		T Phos	pH<2					
931150			AM PM		Ammonia	pH<2					
931151			AM PM		TKN	pH<2					
931152			AM PM		Fecal						
			AM PM								
			AM PM								
			AM PM								
			AM PM								
			AM PM								
			AM PM								

FIELD COMMENTS: CARRIER ______ AIRBILL NO. ______ COOLER NO. ______ DATE SHIPPED ______

RELINQUISHED BY: (Signature)	DATE	TIME	RECEIVED BY: (Signature)	DATE	TIME
		AM PM			AM PM
RELINQUISHED BY: (Signature)	DATE	TIME	RECEIVED BY: (Signature)	DATE	TIME
		AM PM			AM PM
RELINQUISHED BY: (Signature)	DATE	TIME	RECEIVED FOR LABORATORY BY:	DATE	TIME
		AM PM	Amantis	8-20-13	1700 AM PM

LAB RESERVES THE RIGHT TO RETURN UNUSED PORTIONS OF NON-AQUEOUS SAMPLES TO CLIENT.

LAB COMMENTS
In house COC

CONDITIONS UPON RECEIPT: (Check One)
wet X ☐ Iced ☐ Ambient or ______ °C Upon Receipt

MATRIX CODES:

TURN-AROUND TIME (TAT) - SURCHARGES

SW = STANDARD WRITTEN (15 WORKING DAYS) **0%**
RV* = RUSH (5 WORKING DAYS) VERBAL **50%**
RW* = RUSH (5 WORKING DAYS) WRITTEN **75%**
*-Please Call, Expedited services not available for all services.

IV* = IMMEDIATE (3 WORKING DAYS) VERBAL **100%**
IW* = IMMEDIATE (3 WORKING DAYS) WRITTEN **125%**
SP* = WEEKEND, HOLIDAY **Call**

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ORDER # ____

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CHAIN OF CUSTODY RECORD

PAGE ____ OF ____

CLIENT/COMPANY ORDERING TEST	SAMPLER (Signature)	STATE (of Sample Origin)	PWS ID#	PROJECT NAME	PO#
V3 Consultants	Nicole R. Futus	IN		Center Lake	02218
COMPLIANCE MONITORING? YES NO (NO circled)		POPULATION SERVED:	SOURCE WATER: Surface		

EHL LAB#	COLLECTION DATE	COLLECTION TIME	AM/PM	SAMPLING SITE	TEST NAME	SAMPLE REMARKS	Chlorinated Yes	Chlorinated No	# OF CONTAINERS	MATRIX CODE	TURNAROUND TIME
	8/20	1225	AM PM	V3-CLB					6		
	8/20	1240	AM PM	V3-CLS					6		
	8/20	1510	AM PM	V3-PL					7		
			AM PM								
			AM PM								
			AM PM								
			AM PM								
			AM PM								
			AM PM								
			AM PM								
			AM PM								
			AM PM								
			AM PM								

FIELD COMMENTS: CARRIER ____ AIRBILL NO. ____ COOLER NO. ____ DATE SHIPPED ____

RELINQUISHED BY: (Signature)	DATE	TIME	RECEIVED BY: (Signature)	DATE	TIME
Nicole R. Futus	8/20	5:00 AM PM (PM circled)			AM PM
RELINQUISHED BY: (Signature)	DATE	TIME AM PM	RECEIVED BY: (Signature)	DATE	TIME AM PM
RELINQUISHED BY: (Signature)	DATE	TIME AM PM	RECEIVED FOR LABORATORY BY: dmartis	DATE 8-20 03	TIME 1700 AM PM

LAB RESERVES THE RIGHT TO RETURN UNUSED PORTIONS OF NON-AQUEOUS SAMPLES TO CLIENT.

LAB COMMENTS

CONDITIONS UPON RECEIPT: (Check One) ☒ Iced ☐ Ambient or ____ °C Upon Receipt

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Environmental Health Laboratories
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South Bend, IN 46617
Phone: (574) 233-4777
Fax: (574) 233-8207

LABORATORY REPORT

This report contains 7 pages.
(including the cover page)

If you have any questions concerning this report, please do not hesitate to call us at 1-800-332-4345 or 574-233-4777.

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www.ehl.cc

LABORATORY REPORT

Client: V-3 Consultants
Attn: Ed Belmonte
7325 Janes Avenue
Suite 100
Woodridge, IL 60517

Report#: 931889-902

Priority: Standard Written

Status: Final

Project/Site: Center Lake / Multiple

Samples Submitted: Fourteen surface water samples

Copies to: None

Collected: 08/21/03 By: Client Received: 08/21/03

REPORT SUMMARY

Fourteen surface water samples were submitted for multiple parameter analyses.

Note: Total Kjeldahl nitrogen (TKN) analysis performed by Sherry Laboratories, Columbus, IN.

Note: In the Method 4500-P E analysis for sample site V3-WC, the dissolved phosphorus recovery in the MSD at 0.5 mg P/L (89%) was outside the acceptance limits of 90-110%.

Detailed quantitative results are presented on the following pages.

We appreciate the opportunity to provide you with this analysis. If you have any questions concerning this report, please do not hesitate to call us at (574) 233-4777.

Note: This report may not be reproduced, except in full, without written approval from Environmental Health Laboratories (EHL). EHL is accredited by the National Environmental Laboratory Accreditation Program (NELAP). This report satisfies the requirements of your project but has not been prepared to comply with NELAP reporting requirements.

REVIEWED BY: Reporter DATE: 9/10/03

FINALIZED BY: DATE: 9-10-03

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Client: V-3 Consultants | Report#: 931889-902

NITROGEN, AMMONIA—Surface Water

Lab #	Site Description	MRL		Results	
931894	V3-WC	0.1	<	0.1	mg/L
931901	V3-TR	0.1	<	0.1	mg/L

Analyzed: 08/25/03 Analyst: EE Method #: 4500-NH_3 D

NITROGEN, NITRATE—Surface Water

Lab #	Site Description	MCL	MRL	Results (mg/L)
931893	V3-WC	10	0.1	**7.2**
931900	V3-TR	10	0.1	**0.2**

Analyzed: 08/21/03 Analyst: KS Method: 353.2

NITROGEN, NITRITE—Surface Water

Lab #	Site Description	MCL	MRL	Results (mg/L)
931892	V3-WC	1	0.01	< 0.01
931899	V3-TR	1	0.01	< 0.01

Analyzed: 08/21/03 Analyst: KS Method: 353.2

PHOSPHORUS, DISSOLVED—Surface Water

Lab #	Site Description	MRL	Results (mg P/L)
931891	V3-WC	0.05	√ **2.3**
931898	V3-TR	0.05	< 0.05

Analyzed: 08/26 & 09/04/03 Analyst: KS Method: 4500-P E

PHOSPHORUS, TOTAL—Surface Water

Lab #	Site Description	MRL	Results (mg P/L)
931890	V3-WC	0.05	√ **2.0**
931897	V3-TR	0.05	< 0.05

Analyzed: 08/26 & 09/04/03 Analyst: KS Method: 4500-P E

Client: V-3 Consultants

Report#: 931889-902

FECAL COLIFORM —Surface Water

Lab #	Site Description	Limit	Results (cfu/100mL)
931889	V3-WC	200	**490**
931896	V3-TR	200	**150**

Analyzed: 08/21/03 Analyst: HW Method: SM 9222-D

NITROGEN, TOTAL KJELDAHL—Surface Water

Lab #	Site Description	MRL		Results	
931895	V3-WC	1.0	<	1.0	ppm
931902	V3-TR	1.0	<	1.0	ppm

Analyzed: 09/05/03 Analyst: Reference Lab Method #: 351.2

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REFERENCES AND DEFINITIONS OF TERMS

General Chemistry

References:	1. EPA-600/4-79-020 (rev. March 1983) Methods for Chemical Analysis of Water and Wastes. 2. Standard Methods for the Examination of Water and Wastewater, Vol. 19, 1995.

Fecal Coliform

Analytical technique:	Membrane Filtration
Reference:	Standard Methods For Examination of Water and Wastewater Vol. 19, 1995

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1 mg/L = 1 milligram per liter = 1 part per million (ppm)

1 cfu = 1 Colony Forming Unit = a bacteria colony presumed to have originated from a single bacterium present in the sample.

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CHAIN OF CUSTODY RECORD

PAGE ____ OF ____

CLIENT/COMPANY ORDERING TEST	SAMPLER (Signature)	STATE (of Sample Origin)	PWS ID#	PROJECT NAME	PO#
V3 Consultants	NicoleR. Fiths	IN		Center Lake	02218
COMPLIANCE MONITORING? YES NO		POPULATION SERVED:	SOURCE WATER: Surface		

EHL LAB#	COLLECTION DATE	COLLECTION TIME	SAMPLING SITE	TEST NAME	SAMPLE REMARKS	Chlorinated Yes	Chlorinated No	# OF CONTAINERS	MATRIX CODE	TURNAROUND TIME
931889	8/21	10:30 AM PM	V3-WC	see sample bottle Fecal	dissolved phosphorous not			7		
	8/21	1310 AM PM	V3-TR dm 8-21-03	see sample bottled	filtered in field			7		
931890		AM PM		T. Phos						
931891		AM PM	Dissolved	O. Phos						
931892		AM PM		NO2						
931893		AM PM		NO3-353 2						
931894		AM PM		Ammonia	pH<2					
931895		AM PM		TKN	pH<2					
		AM PM								
		AM PM								
		AM PM								
		AM PM								
		AM PM								

FIELD COMMENTS: CARRIER ____ AIRBILL NO. ____ COOLER NO. ____ DATE SHIPPED ____

RELINQUISHED BY: (Signature)	DATE	TIME	RECEIVED BY: (Signature)	DATE	TIME
NicoleR. Fiths	8/21	14:45 AM PM			AM PM
RELINQUISHED BY: (Signature)	DATE	TIME	RECEIVED BY: (Signature)	DATE	TIME
		AM PM			AM PM
RELINQUISHED BY: (Signature)	DATE	TIME	RECEIVED FOR LABORATORY BY:	DATE	TIME
		AM PM	AMartis	8-21-03	1445 AM PM

LAB RESERVES THE RIGHT TO RETURN UNUSED PORTIONS OF NON-AQUEOUS SAMPLES TO CLIENT.

LAB COMMENTS

CONDITIONS UPON RECEIPT (Check One) ☒ Iced ☐ Ambient or ____ °C Upon Receipt

MATRIX CODES:

TURN-AROUND TIME (TAT) - SURCHARGES

SW = STANDARD WRITTEN (15 WORKING DAYS) **0%**
RV* = RUSH (5 WORKING DAYS) VERBAL **50%**
RW* = RUSH (5 WORKING DAYS) WRITTEN **75%**
*-Please Call, Expedited services not available for all services.

IV* = IMMEDIATE (3 WORKING DAYS) VERBAL **100%**
IW* = IMMEDIATE (3 WORKING DAYS) WRITTEN **125%**
SP* = WEEKEND, HOLIDAY **Call**

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CHAIN OF CUSTODY RECORD

PAGE ____ OF ____

CLIENT/COMPANY ORDERING TEST	SAMPLER (Signature)	STATE (of Sample Origin)	PWS ID#	PROJECT NAME	PO#
V3 Consultants	Nicole R. Fileus	IN		Center Lake	02218
COMPLIANCE MONITORING? YES NO		POPULATION SERVED:	SOURCE WATER: Surface		

EHL LAB#	COLLECTION DATE	COLLECTION TIME	AM/PM	SAMPLING SITE	TEST NAME	SAMPLE REMARKS	Chlorinated Yes	Chlorinated No	# OF CONTAINERS	MATRIX CODE	TURNAROUND TIME
—dm 8/21/03	8/21	10:30	AM	V3-WC	see sample bottle	dissolved phosphorous not			7		
931896	8/21	1310	PM	V3-TR	see sample bottled Fecal	filtered in field			7		
931897			AM PM		T Phos 8-21-03						
931898			AM PM		Dissolved Ortho Phos						
931899			AM PM		NO2						
931900			AM PM		NO3-353.2						
931901			AM PM		ammonia	pH<2					
931902			AM PM		TKN	pH<2					
			AM PM								
			AM PM								
			AM PM								
			AM PM								
			AM PM								

FIELD COMMENTS: CARRIER ______ AIRBILL NO. ______ COOLER NO. ______ DATE SHIPPED ______

RELINQUISHED BY: (Signature)	DATE	TIME	RECEIVED BY: (Signature)	DATE	TIME
Nicole R. Fileus	8/21	14:45 PM			AM PM
RELINQUISHED BY: (Signature)	DATE	TIME AM PM	RECEIVED BY: (Signature)	DATE	TIME AM PM
RELINQUISHED BY: (Signature)	DATE	TIME AM PM	RECEIVED FOR LABORATORY BY: A Martis	DATE 8-21-03	TIME 1445 AM PM

LAB RESERVES THE RIGHT TO RETURN UNUSED PORTIONS OF NON-AQUEOUS SAMPLES TO CLIENT.

LAB COMMENTS

CONDITIONS UPON RECEIPT: (Check One) ☒ Iced ☐ Ambient or ______ °C Upon Receipt

MATRIX CODES:

TURN-AROUND TIME (TAT) - SURCHARGES

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RV* = RUSH (5 WORKING DAYS) VERBAL 50%
RW* = RUSH (5 WORKING DAYS) WRITTEN 75%
*-Please Call, Expedited services not available for all services.

IV* = IMMEDIATE (3 WORKING DAYS) VERBAL 100%
IW* = IMMEDIATE (3 WORKING DAYS) WRITTEN 125%
SP* = WEEKEND, HOLIDAY Call

STAT* = LESS THAN 48 HOURS Call
Samples received unannounced with less than 48 hours holding time remaining may be subject to additional surcharges.

Laboratory Report

Customer: 991
V3 Consultants

Mailing:
V3 Consultants
ATTN: Ed Belmonte
7325 James Ave. Suite 100
Woodridge, IL 60517

Billing:
V3 Consultants
ATTN: Ed Belmonte
7325 James Ave. Suite 100
Woodridge, IL 60517

Sample: 79558
V3-TR (1)
Desc Code: STUDY
Date Sampled: 08/22/03 Time: 9:55 AM
Date Received: 08/22/03
Date Reported: 09/23/03
P.O. Number:
PWS_ID:
Status: Completed

Turner Tech, LLC
Certified Public Health Laboratory #: MC-43-1
USDA Laboratory Code #: 3659
560 S. Zimmer Road - P.O. Box 1096
Warsaw, Indiana 46581-1096
Voice: 574-267-3305 / Fax:574-269-6569

Test Description / *Reference Method:*	Result	Units / QC-If Applicable	MDL	Lab Method #	Batch #	Date and Time	Analyst
Fecal Coliform MF	2400	/100		9222D	93766	08/22/03 1:30:00 PM	WL
Ref: 9222 D Fecal Coliform Membrane Filter Procedure		Comments:					
E Coli	520	/100		9223B	93767	08/22/03 3:30:00 PM	WL
Ref: QT 9223B E Coli		Comments:					
Nitrate Nitrogen	0.38	mg/L	0.2	4500NO3D	93782	08/22/03 4:30:00 PM	SB
		QC-Nitrate Nitrogen		94.74%	returned from QC DUP		
		QC-Nitrate Nitrogen		93.00%	returned from QC SPK		
Ref: 4500 NO3 D Nitrate Nitrogen Electrode Method		Comments:					
Nitrite Nitrogen	0.01	mg/L	0.01	4500NO2B	94286	08/22/03 9:40:00 AM	SB
		QC-Nitrite Nitrogen		100.00%	returned from QC DUP		
		QC-Nitrite Nitrogen		100.00%	returned from QC SPK		
Ref: 4500 NO2 B Nitrite Nitrogen Colorimetric Method		Comments:					
Phosphorus Total	ND	mg/L	0.01	4500PB5E	93821	08/27/03 3:00:00 PM	WL
Ref: 4500 P B 5 E H2SO4-HNO3, Ascorbic Acid		Comments:					
Phosphorus Dis	ND	mg/L	0.01	4500PB15E	93824	08/27/03 3:00:00 PM	WL
Ref: 4500 P B 1 5 E Filtered, Persulfate, Ascorbic Acid		Comments:					
Ammonia Nitrogen	ND	mg/L	0.1	4500NH3F	93948	08/29/03 1:00:00 PM	EM
Ref: 4500 NH3 F Ammonia Selective Electrode		Comments:					
Kjeldahl Nitrogen	0.82	mg/L	0.4	4500NORGB	94097	09/05/03 1:45:00 PM	EM
Ref: 4500 NORG B Nitrogen Macro-Kjeldahl Method		Comments:					

A result of "ND" indicates None Detected. For bacteriological results "ND" indicates negative. Zeros to the right of the decimal point and/or to the right of a digit are not significant. ie: 10.00 = 10; 1.00 = 1; 1.10 = 1.1 MDL - Minimum Detection Level concentration reportable >0 with 99% confidence in an aqueous matrix.

All testing is conducted in accordance with Turner Tech, LLC "Quality Control / Quality Assurance Manual" and the following regulations as applicable: 40 CFR Part 136, 40 CFR Part 261, or PL 91-597.

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Approved By: David M Turner

Laboratory Report

Turner Tech, LLC

Certified Public Health Laboratory #: MC-43-1
USDA Laboratory Code #: 3659
560 S. Zimmer Road - P.O. Box 1096
Warsaw, Indiana 46581-1096
Voice: 574-267-3305 / Fax:574-269-6569

Customer: 991
V3 Consultants

Mailing:
V3 Consultants
ATTN: Ed Belmonte
7325 James Ave. Suite 100
Woodridge, IL 60517

Billing:
V3 Consultants
ATTN: Ed Belmonte
7325 James Ave. Suite 100
Woodridge, IL 60517

Sample: 79559
V3-PL (2)
Desc Code: STUDY
Date Sampled: 08/22/03 Time: 10:25 AM
Date Received: 08/22/03
Date Reported: 09/23/03
P.O. Number:
PWS_ID:
Status: Completed

Test Description / *Reference Method:*	Result	Units / QC-If Applicable	MDL	Lab Method #	Batch #	Date and Time	Analyst
Fecal Coliform MF	900	/100		9222D	93766	08/22/03 1:30:00 PM	WL
Ref: 9222 D Fecal Coliform Membrane Filter Procedure			Comments:				
E Coli	90	/100		9223B	93767	08/22/03 3:30:00 PM	WL
Ref: QT 9223B E Coli			Comments:				
Nitrate Nitrogen	0.32	mg/L	0.2	4500NO3D	93782	08/22/03 4:30:00 PM	SB
		QC-Nitrate Nitrogen		94.74%	returned from QC DUP		
		QC-Nitrate Nitrogen		93.00%	returned from QC SPK		
Ref: 4500 NO3 D Nitrate Nitrogen Electrode Method			Comments:				
Nitrite Nitrogen	0.02	mg/L	0.01	4500NO2B	94286	08/22/03 9:40:00 AM	SB
		QC-Nitrite Nitrogen		100.00%	returned from QC DUP		
		QC-Nitrite Nitrogen		100.00%	returned from QC SPK		
Ref: 4500 NO2 B Nitrite Nitrogen Colorimetric Method			Comments:				
Phosphorus Total	ND	mg/L	0.01	4500PB5E	93821	08/27/03 3:00:00 PM	WL
Ref: 4500 P B 5 E H2SO4-HNO3, Ascorbic Acid			Comments:				
Phosphorus Dis	ND	mg/L	0.01	4500PB15E	93824	08/27/03 3:00:00 PM	WL
Ref: 4500 P B 1 5 E Filtered, Persulfate, Ascorbic Acid			Comments:				
Ammonia Nitrogen	ND	mg/L	0.1	4500NH3F	93948	08/29/03 1:00:00 PM	EM
Ref: 4500 NH3 F Ammonia Selective Electrode			Comments:				
Kjeldahl Nitrogen	1.4	mg/L	0.4	4500NORGB	94097	09/05/03 1:45:00 PM	EM
Ref: 4500 NORG B Nitrogen Macro-Kjeldahl Method			Comments:				

A result of "ND" indicates None Detected. For bacteriological results "ND" indicates negative. Zeros to the right of the decimal point and/or to the right of a digit are not significant. ie: 10.00 = 10; 1.00 = 1; 1.10 = 1.1 MDL - Minimum Detection Level concentration reportable >0 with 99% confidence in an aqueous matrix.

All testing is conducted in accordance with Turner Tech, LLC "Quality Control / Quality Assurance Manual" and the following regulations as applicable: 40 CFR Part 136, 40 CFR Part 261, or PL 91-597.

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Approved By: David M Turner

Laboratory Report

Turner Tech, LLC

Certified Public Health Laboratory #: MC-43-1
USDA Laboratory Code #: 3659
560 S. Zimmer Road - P.O. Box 1096
Warsaw, Indiana 46581-1096
Voice: 574-267-3305 / Fax:574-269-6569

Customer: 991
V3 Consultants

Mailing:
V3 Consultants
ATTN: Ed Belmonte
7325 James Ave. Suite 100
Woodridge, IL 60517

Billing:
V3 Consultants
ATTN: Ed Belmonte
7325 James Ave. Suite 100
Woodridge, IL 60517

Sample: 79560
V3-WC (3)
Desc Code: STUDY
Date Sampled: 08/22/03 Time: 10:42 AM
Date Received: 08/22/03
Date Reported: 09/23/03
P.O. Number:
PWS_ID:
Status: Completed

Test Description / *Reference Method:*	Result	Units / QC-If Applicable	MDL	Lab Method #	Batch #	Date and Time	Analyst
Fecal Coliform MF	4000	/100		9222D	93766	08/22/03 1:30:00 PM	WL
Ref: 9222 D Fecal Coliform Membrane Filter Procedure		Comments:					
E Coli	3450	/100		9223B	93767	08/22/03 3:30:00 PM	WL
Ref: QT 9223B E Coli		Comments:					
Nitrate Nitrogen	6	mg/L	0.2	4500NO3D	93782	08/22/03 4:30:00 PM	SB
		QC-Nitrate Nitrogen		94.74% returned from QC DUP			
		QC-Nitrate Nitrogen		93.00% returned from QC SPK			
Ref: 4500 NO3 D Nitrate Nitrogen Electrode Method		Comments:					
Nitrite Nitrogen	0.01	mg/L	0.01	4500NO2B	94286	08/22/03 9:40:00 AM	SB
		QC-Nitrite Nitrogen		100.00% returned from QC DUP			
		QC-Nitrite Nitrogen		100.00% returned from QC SPK			
Ref: 4500 NO2 B Nitrite Nitrogen Colorimetric Method		Comments:					
Phosphorus Total	1.2	mg/L	0.01	4500PB5E	93821	08/27/03 3:00:00 PM	WL
Ref: 4500 P B 5 E H2SO4-HNO3, Ascorbic Acid		Comments:					
Phosphorus Dis	1.2	mg/L	0.01	4500PB15E	93824	08/27/03 3:00:00 PM	WL
Ref: 4500 P B 1 5 E Filtered, Persulfate, Ascorbic Acid		Comments:					
Ammonia Nitrogen	ND	mg/L	0.1	4500NH3F	93948	08/29/03 1:00:00 PM	EM
Ref: 4500 NH3 F Ammonia Selective Electrode		Comments:					
Kjeldahl Nitrogen	1.2	mg/L	0.4	4500NORGB	94097	09/05/03 1:45:00 PM	EM
Ref: 4500 NORG B Nitrogen Macro-Kjeldahl Method		Comments:					

A result of "ND" indicates None Detected. For bacteriological results "ND" indicates negative. Zeros to the right of the decimal point and/or to the right of a digit are not significant. ie: 10.00 = 10; 1.00 = 1; 1.10 = 1.1 MDL - Minimum Detection Level concentration reportable >0 with 99% confidence in an aqueous matrix.

All testing is conducted in accordance with Turner Tech, LLC "Quality Control / Quality Assurance Manual" and the following regulations as applicable: 40 CFR Part 136, 40 CFR Part 261, or PL 91-597.

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Approved By: David M Turner

560 S. ZIMMER RD.
P.O. BOX 1096
Warsaw, IN 46581-1096

Turner Tech, LLC

TELEPHONE: 574/267-3305
FAX: 574/269-6569
Web: www.turnertech.net

CHAIN OF CUSTODY RECORD

CLIENT/COMPANY ORDERING TEST: V3 CONSULTANTS
ADDRESS #1: 7325 JANES AVE
ADDRESS #2:
CITY: WOODRIDGE STATE: IL ZIP: 60517

TELEPHONE: 630-330-7169
RESULTS TO: ED BELMONTE
INVOICES TO: ED BELMONTE

TESTS REQUESTED (✔) See List on Back
METHOD NO.: Nitrate &; TKN; Ammonia Nitrogen; Total Phosphorus; Dissolved Phosphorus; Nitrite; Fecal Coliform / E-Coli; Total Bottles

ONE LINE PER BOTTLE

SAMPLE NO. LAB USE ONLY	OUTFALL	SAMPLE DESCRIPTION	COLLECTION DATE	COLLECTION TIME	COMPOSITE (C) OR GRAB (G)	PRESERVATIVE	MATRIX CODE	TOTAL BOTTLES	REMARKS
79558		V3-TR (1)	8-22-03	9:55	G			4	
79559		V3-PL (2)	8/22/03	10:25	G			4	
79560		V3-WC (3)	8/22/03	10:42	G			4	

SAMPLED BY: (Signature) William J. Hilliard

FIELD COMMENTS:

LAB RESERVES THE RIGHT TO RETURN UNUSED PORTIONS OF SAMPLES TO CLIENT.

RELINQUISHED BY: (Signature)	DATE	TIME	RECEIVED BY: (Signature)	DATE	TIME
William J. Hilliard	8/22/03	10:50			
			RECEIVED FOR LABORATORY BY: (Signature) Judy Leverett	8/22/03	10:52A

LAB COMMENTS

PRESERVATIVES
NP = NO PRESERVATIVES
C = COOL TO 4°C
HNO_3 = NITRIC ACID
H_2SO_4 = SULFURIC ACID
NaOH = SODIUM HYDROXIDE

MATRIX CODES:
DW = DRINKING WATER
GW = GROUND WATER
SW = SURFACE WATER
SO = SOIL
SE = SEDIMENT
SL = SLUDGE
HW = HAZARDOUS WASTE
WW = WASTE WATER
PW = POOL WATER
O = OTHER

TURN-AROUND TIME - SURCHARGES
*Please check one box. If none is checked, lab will execute standard turn-around time.
☐ STANDARD WRITTEN 0%
☐ RUSH (3-5 WORKING DAYS) VERBAL 50%
☐ IMMEDIATE (24-48 HOURS) VERBAL 100%

CUSTOMER KEEP PINK COPY. SEND ALL OTHER COPIES TO LAB.

-----Original Message-----
From: Carole Lembi [mailto:lembi@purdue.edu]
Sent: Friday, September 05, 2003 2:02 PM
To: Nicole Titus
Subject: Samples

Nicole: I have just finished looking at the three samples, both fresh and subsamples that we preserved with Lugol's in order to get the organisms to sink to the bottom of the jars.

I see very little in the way of phytoplankton (or zooplankton for that matter) in the samples. The fresh samples are very clear, and when I look at either them or the Lugolized samples under the microscope, there is virtually nothing to identify or count. This includes Cylindrospermopsis and all of the other nasty blue-greens that are typical. If Cylindro is in there, it is at such low levels that it would be impossible to get a count. I did see one curly-que filament that could be Cylindro, but it did not have the typical terminal heterocysts, and so I am not even sure of the ID.

What makes you think that Cylindro is present in Center Lake? I see no evidence of it. Carole

PhycoTech
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St. Joseph, MI 49085
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Fax:(269) 983-3653
info@phycotech.com
http://www.phycotech.com

Algae with Biovolume Analysis
Report and Data Set

Prepared for: 192
Calc Type: Phytoplankton - Tow Volume Provided

Tracking Code:	040001-192	**Sample ID**	CL01
Job:	192	**Replicate #**	.
Job Number:	1	**Level**	Composite
System:	Center Lake	**Depth**	0
Date:	8/19/2004	**Preservative**	Glutaraldehyde
Station:	01		
Site:	42 Foot Hole		

Report Notes .

Taxa Id	*Genus*	*Species*	*Subspecies*	*Variety*	*Form*	*Morph*	*Structure*	*Gald* µm	*Concentration* NU/ml	*Relative Concentration*	*Total Biovolume* µm^3/ml	*Relative Total Biovolume*
Division:	**Bacillariophyta**											
1432	*Aulacoseira*	*granulata*	.		.	*straight*	Vegetative	240	0.285	0.47	3,435.116	11.18
1431	*Aulacoseira*	*ambigua*	.	.	.	.	Vegetative	55	2.990	4.88	4,649.484	15.13
1071	*Cyclotella*	*sp. 1*	.	.	.	.	Vegetative	6	0.427	0.70	36.230	0.12
							TOTAL Bacillariophyta		**3.702**	**6.05**	**8,120.830**	**26.42**
Division:	**Chlorophyta**											
2683	**Chlorococcaceae*	*spp*		.		*2-9.9 um spherical*	Vegetative	8	0.142	0.23	38.168	0.12
2080	*Chlamydomonas*	*spp*	.			.	Vegetative	8	0.427	0.70	64.408	0.21
☑ 2110	*Chlorogonium*	*spp*	.				Vegetative	12	0.142	0.23	6.441	0.02
2340	*Mougeotia*	*spp*	.		.	.	Vegetative	240	0.712	1.16	2,146.948	6.99
2363	*Oocystis*	*parva*	.			.	Vegetative	6	0.142	0.23	4.026	0.01
2385	*Pediastrum*	*simplex*	.	.			Vegetative	100	0.142	0.23	4,082.144	13.28
2480	*Scenedesmus*	*spp*	.	.	.	.	Vegetative	4	0.285	0.47	2.386	0.01
2491	*Schroederia*	*judayi*	.	.			Vegetative	30	0.142	0.23	16.102	0.05
							TOTAL Chlorophyta		**2.136**	**3.49**	**6,360.622**	**20.70**
Division:	**Chrysophyta**											
1413	*Dinobryon*	*spp*		.		.	Vegetative	49.5	2.563	4.19	322.042	1.05

☑ – Identification is uncertain

* - Family level identification

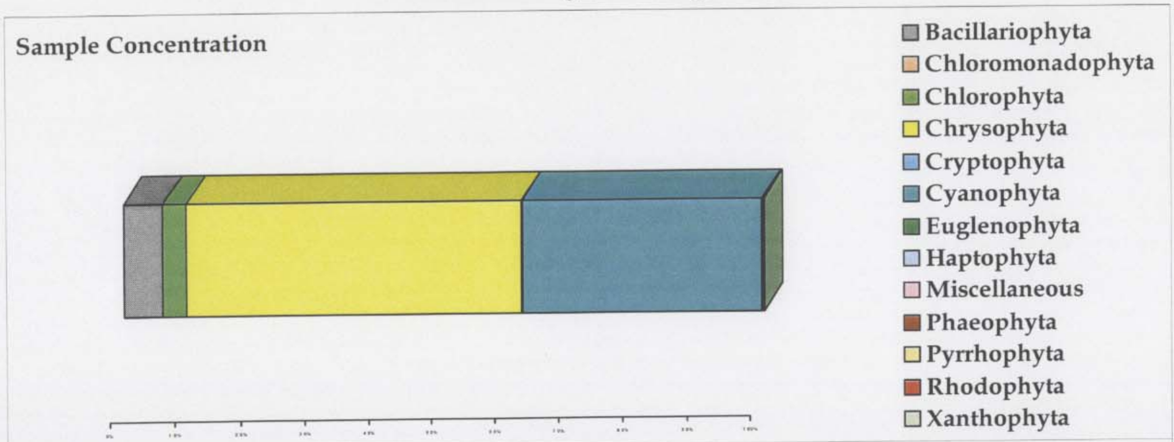
1123	*Dinobryon*	*spp*			Monad	8	29.471	48.14	2,798.188	9.10
					TOTAL Chrysophyta		**32.034**	**52.33**	**3,120.230**	**10.15**
Division:	**Cryptophyta**									
3043	*Rhodomonas*	*minuta*	*nannoplanctica*		Vegetative	6	0.142	0.23	4.175	0.01
					TOTAL Cryptophyta		**0.142**	**0.23**	**4.175**	**0.01**
Division:	**Cyanophyta**									
4018	*Anabaena*	*planctonica*			Vegetative	202.6667	0.997	1.63	6,566.177	21.36
4041	*Aphanizomenon*	*flos-aquae*			Vegetative	100.5	0.570	0.93	439.006	1.43
4054	*Aphanocapsa*	*delicatissima*			Vegetative	30	1.281	2.09	20.128	0.07
4062	*Aphanothece*	*nidulans*			Vegetative	30	0.142	0.23	2.982	0.01
4091	*Coelosphaerium*	*naegelianum*			Vegetative	40	0.142	0.23	286.260	0.93
4153	*Lyngbya*	*limnetica*			Vegetative	200	0.142	0.23	20.128	0.07
4161	*Merismopedia*	*tenuissima*			Vegetative	8	0.142	0.23	1.193	0.00
4166	*Merismopedia*	*warmingiana*			Vegetative	20	0.570	0.93	0.895	0.00
107379	*Microcystis*	*flos-aquae*			Vegetative	48	0.028	0.04	248.850	0.81
4183	*Oscillatoria*	*agardhii*			Vegetative	370	0.285	0.47	1,323.951	4.31
☑ 4368	*Oscillatoria*	*amphibia*			Vegetative	50	0.285	0.47	100.638	0.33
4285	*Synechocystis*	*spp*		*>1 um spherical*	Vegetative	2	18.366	30.00	76.933	0.25
					TOTAL Cyanophyta		**22.950**	**37.49**	**9,087.140**	**29.57**
Division:	**Miscellaneous**									
7140	*	*spp*		*Microflagellate*	Vegetative	8	0.142	0.23	36.283	0.12
					TOTAL Miscellaneous		**0.142**	**0.23**	**36.283**	**0.12**
Division:	**Pyrrhophyta**									
6011	*Ceratium*	*hirundinella*			Vegetative	208	0.083	0.13	3,999.577	13.01
6044	*Peridinium*	*umbonatum*			Vegetative	12	0.028	0.04	5.530	0.02
					TOTAL Pyrrhophyta		**0.110**	**0.18**	**4,005.107**	**13.03**

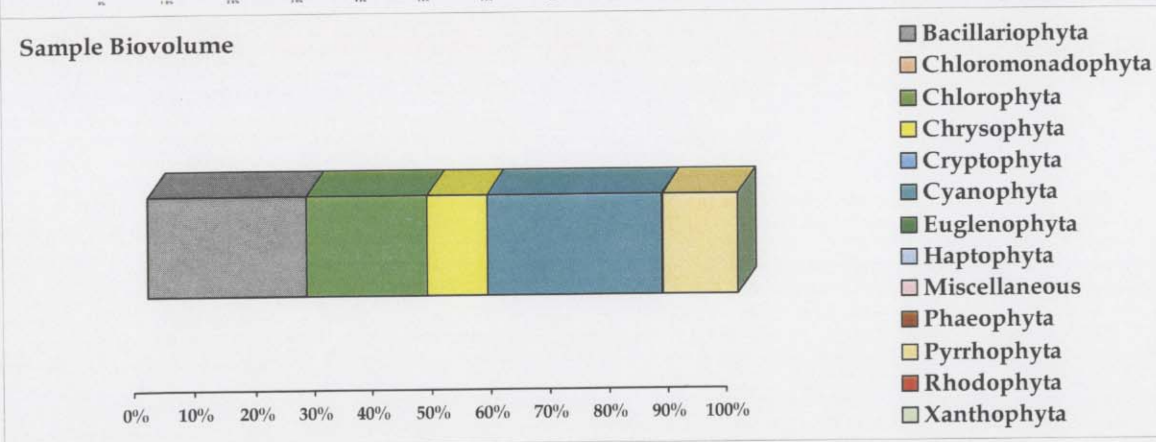
☑ = Identification is uncertain
* Family level identification

Summary Graphics

Total Sample Concentration
61.216

Total Sample Biovolume
30,734.387





☑ = Identification is uncertain
* = Family level identification

Species List

Taxa Code	Genus	Species	Subspecies	Variety	Form	Morph	Structure	Authority
Division: Bacillariophyta								
1431	*Aulacoseira*	*ambigua*					Vegetative	(Grunow) Simonsen
1432	*Aulacoseira*	*granulata*				*straight*	Vegetative	(Ehrenb.) Simonsen
1071	*Cyclotella*	*sp. 1*					Vegetative	(Kutzing) de Brebisson
Division: Chlorophyta								
2683	*Chlorococcaceae*	*spp*				*2-9.9 um spherical*	Vegetative	N/A
2080	*Chlamydomonas*	*spp*					Vegetative	Ehrenberg
2110	*Chlorogonium*	*spp*					Vegetative	Dang
2340	*Mougeotia*	*spp*					Vegetative	Kisselew
2363	*Oocystis*	*parva*					Vegetative	West & West
2385	*Pediastrum*	*simplex*					Vegetative	Meyen Lemm
2480	*Scenedesmus*	*spp*					Vegetative	Meyen
2491	*Schroederia*	*judayi*					Vegetative	G. M. Smith
Division: Chrysophyta								
1123	*Dinobryon*	*spp*					Monad	Ehrenberg
1413	*Dinobruon*	*spp*					Vegetative	Ehrenberg
Division: Cryptophyta								
3043	*Rhodomonas*	*minuta*		*nannoplanctica*			Vegetative	Skuja
Division: Cyanophyta								
4018	*Anabaena*	*planctonica*					Vegetative	Brunnthaler
4041	*Aphanizomenon*	*flos aquae*					Vegetative	(L.) Ralfs
4054	*Aphanocapsa*	*delicatissima*					Vegetative	West & West
4062	*Aphanothece*	*nidulans*					Vegetative	P. Richter
4091	*Coelosphaerium*	*naegelianum*					Vegetative	Unger
4153	*Lyngbya*	*limnetica*					Vegetative	Lemmermann
4161	*Merismopedia*	*tenuissima*					Vegetative	Lemmermann
4166	*Merismopedia*	*warmingiana*					Vegetative	Lagerheim
107379	*Microcystis*	*flos-aquae*					Vegetative	(Wittr.) Kirchn.
4183	*Oscillatoria*	*agardhii*					Vegetative	Gomont
4368	*Oscillatoria*	*amphibia*					Vegetative	Agardh

☑ = Identification is uncertain
* Family level identification

4285	*Synechocystis*	*spp*	.		.	*>1 um spherical*	Vegetative	N/A

Division: Miscellaneous

7140	.	*spp*	.	.	.	*Microflagellate*	Vegetative	N/A

Division: Pyrrhophyta

6011	*Ceratium*	*hirundinella*	.		.		Vegetative	Dujardin
6044	*Peridinium*	*umbonatum*	.	.	.	.	Vegetative	Stein

☑ = Identification is uncertain

* - Family level identification

PhycoTech, Inc.

620 Broad Street · Suite 100 · St. Joseph · MI 49085 · Phone: 269-983-3654 · Fax: 269-983-3653
info@phycotech.com · www.phycotech.com

Analysis Request Form

Client Information

Company Name: V3 Consultants
Contact Name: Ed Belmonte
Address: 7325 Janes Ave
Suite 100

City: Woodridge State: Illinois
Zip: 60517 Country: USA
Phone: 630-724-9200
Fax: 630-724-9202
Email: EBelmonte@V3Consultants.com
Date: 08-19-2004

Billing Information

Company Name: V3 Consultants
Contact Name: Ed Belmonte
Address: 7325 Janes Ave
Suite 100

City: Woodridge State: Illinois
Zip: 60517 Country: USA
Phone: 630-724-9200
Fax: 630-724-9202
Email: EBelmonte@V3 Consultants.com
Purchase Order #:

Number of samples in this shipment: 1

Sample(s) taken from: ☐Stream ☒Lake ☐Estuary ☐Marine ☐Other ______

Analyses Requested

Taxa Level	Algae	☐Division	☐Genus	☐Species[1]	☒Species BG[2]	☐Archive Only	☐Sediment Cores
	Zooplankton	☐Genus	☐Species[1]	☐Archive Only			
	Macroinvertebrate	☐Family	☐Genus	☐Species[1]			
Biovolume/Biomass Estimates	Algae	☒Yes	☐No				
	Zooplankton	☐Yes	☐No				
Related Services	Bacteria	☐Yes	☐No				
	Photography	☐Yes	☐No				
	Chlorophyll *a*	☒Yes	☐No				
	Culturing	☐Yes	☐No				
	Identifications, Data & Graphical Analysis	☐Yes	☐No				

[1] We strive to identify all organisms to species level. However, due to the availability of taxonomic keys, condition of samples, and the density of samples, this may not be possible. We will always identify specimens to the "lowest practical level" consistent with customer requests.

[2] Species count on blue-greens only, other taxa to genus

Sample Data Sheet

Sample Date	Sample ID	Water System Name	Site	Station	Sample Depth[1]	Sample Type[2]	Sample Volume	Sample Area or Weight	Tow Sample Volume	Tow Volume	Tow Net Diameter	Tow Net Depth	Preservative[3]
8-19-04	CL01	Center Lake	42 foot hole	01	COMP	PHYT					8 inch	30 feet	Live
											= 0.2032m	= 9.144m	
										~~[illegible]~~			
										0.2965 m^3			
										πr^2			
										r = 4 inches			
										0.2965 m^3			

[1] Sample Depth: Epilimnion=EPI; Pooled Epilimion=PEPI; Metalimnion=META; Hypolimnion=HYPO; Composite=COMP; Benthic=BENT

[2] Sample Type: Please refer to the "Sample Type Calculation Information" form attached. All calculation variables (i.e. total sample volume, etc.) that must be provided for the specified Sample Type are listed.

[3] Preservative: Ethanol=ETH; Formaldehyde=F-Hyde; Formalin=F-Lin; Gluteraldehyde=GLUT; Live=LIVE; Lugols=LUG; M3 Fixative=M3; Methanol=METH; MP3=MP3

PhycoTech, Inc.
620 Broad Street - Suite 100 - St. Joseph - MI 49085 - Phone: 269-983-3654 - Fax: 269-983-3653
info@phycotech.com - www.phycotech.com

Sample Type	Abbreviations[1]	It is our goal to eliminate confusion regarding sample receipt and data analysis. Please provide PhycoTech with the requested information designated for each sample type. This procedure will improve our efficiency, increase data accuracy, and speed up the analysis process. Please feel free to contact us with any questions or concerns.
Sediment Core	SEDI	
Epiphyton	EPIPHYT	Please include Sample Volume (mL or L) and Sample Weight (mg or g) for each Epiphyte Sample
Macroinvertabrate	MACRO	MAY require Sample Area (cm2 or m2) if Whole Density Count analysis is requested.
Periphyton	PERI	Please include Sample Volume (mL or L) and Sample Area (cm2 or m2) for each Periphyton Sample
Zebra Mussel Veliger	ZMV	Please include Total Sample Volume (mL or L) If the sample has already been concentrated the Sub Sample Volume (mL or L) is required in addition to the Total Sample Volume
Phytoplankton	PHYT	ONLY in the case of a Phytoplankton Tow please include: Sample Volume (mL or L) and Tow Volume (m3 or L), or Sample Volume (mL or L), Tow Net Diameter (cm or m) and Tow Net Depth (m) for each Phytoplankton Tow Sample
Zooplankton	ZOOP	Please include: Sample Volume (mL or L) and Tow Volume (m3 or L), or Sample Volume (mL or L), Tow Net Diameter (cm or m) and Tow Net Depth (m) for each Zooplankton Sample

[1] Use these abbreviations when entering information in the "Sample Type" column on the sample data sheet.

Ed Belmonte

From: Shelley Vaughn [svaughn@phycotech.com]
Sent: Thursday, December 30, 2004 9:50 AM
To: Ed Belmonte
Subject: Re: Read: Data Delivery

Ed,

I've spoken with Ann and she said it would be better to resubmit a sample and have the count and the chlorophyll a analysis done from the same sample. So disregard the invoice for the count. Again, I do apologize for any inconvenience this has caused you!

Thank you for your patience!

Best regards,
Shelley

At 03:09 PM 12/2/2004, you wrote:

> Your message
>
> To: Ed Belmonte
> Subject: Data Delivery
> Sent: Thu, 2 Dec 2004 10:46:03 -0600
>
> was read on Thu, 2 Dec 2004 14:09:08 -0600
>
> Final-Recipient: RFC822; EBelmonte@v3consultants.com
> Disposition: automatic-action/MDN-sent-automatically; displayed
> X-MSExch-Correlation-Key: HbrlkfDPtEGmB/3SYf1lkw==

Shelley Vaughn
Laboratory Manager
PhycoTech, Inc.
Phone: 1.269.983.3654
Fax: 1.269.983.3653
E Fax: 1.866.728.5579
mailto:svaughn@phycotech.com
www.phycotech.com

PhycoTech, Inc.
620 Broad Street - Suite 100 - St. Joseph - MI 49085 - Phone: 269-983-3654 - Fax: 269-983-3653
info@phycotech.com - www.phycotech.com

Customer ID: 192
Customer Name: V3 Consultan

Chlorophyll a Analysis

Sample ID	Tracking ID	Chlorophyll a (µg/L)
CL02	050002-192	112.00

PhycoTech, Inc.
620 Broad Street - Suite 100 - St. Joseph - MI 49085 - Phone: 269-983-3654 - Fax: 269-983-3653
info@phycotech.com - www.phycotech.com

Algae Analysis
Report and Data Set

Customer ID: 192

Tracking Code: 050001-192 | **Sample ID:** CL02 | **Replicate:** 1
Customer ID: 192 | **Sample Date:** 8/16/2005 | **Sample Level:** Composite
Job ID: 1 | **Station:** 01 | **Sample Depth:** 9.14
System Name: Center Lake | **Site:** 42 Foot Hole | **Preservative:** Glutaraldehyde
Report Notes: .

Division: Bacillariophyta

Taxa ID	Genus	Species	Subspecies	Variety	Form	Morph	Structure	Count NU/ml	Relative Count	Algal Cell Count Cells/ml	Relative Algal Cell Count
1000415	*Rhizosolenia*	*longiseta*	.	.	.	.	Vegetative	0.247	0.51	0.247	0.08
9363	*Cyclotella*	*ocellata*	.	.	.	.	Vegetative	19.775	40.62	19.775	6.45
1431	*Aulacoseira*	*ambigua*	.	.	.	.	Vegetative	0.906	1.86	3.354	1.09
1432	*Aulacoseira*	*granulata*	.	.	.	straight	Vegetative	0.021	0.04	0.149	0.05
9504	*Synedra*	*tenera*	.	.	.	.	Vegetative	0.494	1.02	0.494	0.16
1315	*Synedra*	*ulna*	.	.	.	.	Vegetative	0.021	0.04	0.021	0.01
9212	*Cocconeis*	*placentula*	.	lineata	.	.	Vegetative	0.082	0.17	0.082	0.03
Summary for Division ~ Bacillariophyta (7 detail records)						**Sum Total**	**Bacillariophyta**	21.548	44.26	24.123	7.86

Division: Chlorophyta

Taxa ID	Genus	Species	Subspecies	Variety	Form	Morph	Structure	Count NU/ml	Relative Count	Algal Cell Count Cells/ml	Relative Algal Cell Count
2567	*Tetraedron*	*regulare*	.	incus	.	.	Vegetative	0.082	0.17	0.082	0.03
2340	*Mougeotia*	*spp*	.	.	.	.	Vegetative	0.165	0.34	0.247	0.08
2761	*Phacotus*	*lendneri*	.	.	.	.	Vegetative	0.082	0.17	0.082	0.03

2462	*Quadrigula*	*lacustris*	.	.	.	.	Vegetative	0.082	0.17	0.082	0.03
2385	*Pediastrum*	*simplex*	.	.	.	.	Vegetative	0.064	0.13	1.535	0.50
2381	*Pediastrum*	*spp*	.	.	.	.	Vegetative	0.082	0.17	2.637	0.86
2367	*Oocystis*	*pusilla*	.	.	.	.	Vegetative	0.082	0.17	0.082	0.03
2363	*Oocystis*	*parva*	.	.	.	.	Vegetative	0.165	0.34	0.412	0.13
2853	*Lagerheimia*	*quadriseta*	.	.	.	.	Vegetative	0.082	0.17	0.330	0.11
2035	*Ankistrodesmus*	*convolutus*	.	.	.	.	Vegetative	0.165	0.34	0.165	0.05
2031	*Ankistrodesmus*	*falcatus*	.	.	.	monoraphidiod	Vegetative	0.165	0.34	0.165	0.05
2080	*Chlamydomonas*	*spp*	.	.	.	.	Vegetative	0.165	0.34	0.165	0.05
1000012	*Closterium*	*spp*	.	.	.	.	Vegetative	0.021	0.04	0.021	0.01
2185	*Cosmarium*	*tenue*	.	.	.	.	Vegetative	0.412	0.85	0.412	0.13
1000072	*Dictyosphaerium*	*chlorelloides*	.	.	.	.	Vegetative	0.082	0.17	0.330	0.11
2331	*Micractinium*	*pusillum*	.	.	.	.	Vegetative	0.082	0.17	0.082	0.03
2683	**Chlorococcaceae*	*spp*	.	.	.	2-9.9 um spherical	Vegetative	0.494	1.02	0.494	0.16

Summary for Division ~ Chlorophyta (17 detail records) **Sum Total Chlorophyta** 2.475 5.08 7.324 2.39

Division: Chrysophyta

Taxa ID	Genus	Species	Subspecies	Variety	Form	Morph	Structure	Count NU/ml	Relative Count	Algal Cell Count Cells/ml	Relative Algal Cell Count
1180	*Mallomonas*	*spp*	.	.	.	.	Vegetative	0.247	0.51	0.247	0.08

Summary for Division ~ Chrysophyta (1 detail record) **Sum Total Chrysophyta** 0.247 0.51 0.247 0.08

Division: Cyanophyta

Taxa ID	Genus	Species	Subspecies	Variety	Form	Morph	Structure	Count NU/ml	Relative Count	Algal Cell Count Cells/ml	Relative Algal Cell Count
107576	*Lyngbya*	*lagerheimia*	.	minor	.	.	Vegetative	0.165	0.34	1.978	0.64

4242	*Gomphosphaeria*	*lacustris*	.	.	.	.	Vegetative	0.165	0.34	2.472	0.81
☑ 4023	*Cylindrospermopsis*	*raciborskii*	.	.	.	straight	Vegetative	0.082	0.17	0.824	0.27
4153	*Lyngbya*	*limnetica*	.	.	.	.	Vegetative	1.566	3.22	31.519	10.28
4331	*Anabaena*	*macrospora*	.	.	.	.	Vegetative	0.247	0.51	0.906	0.30
4285	*Synechocystis*	*spp*	.	.	.	>1 um spherical	Vegetative	9.393	19.29	9.393	3.06
4018	*Anabaena*	*planctonica*	.	.	.	.	Vegetative	0.082	0.17	0.330	0.11
☑ 4421	*Lyngbya*	*subtilis*	.	.	.	.	Vegetative	0.082	0.17	3.296	1.07
4161	*Merismopedia*	*tenuissima*	.	.	.	.	Vegetative	0.330	0.68	3.296	1.07
4183	*Oscillatoria*	*agardhii*	.	.	.	.	Vegetative	0.165	0.34	25.817	8.42
☑ 4368	*Oscillatoria*	*amphibia*	.	.	.	.	Vegetative	1.071	2.20	22.708	7.40
4321	*Synechococcus*	*elongatus*	.	.	.	.	Vegetative	0.082	0.17	0.082	0.03
☑ 4332	*Anabaena*	*aphanizomenoides*	.	.	.	.	Vegetative	0.082	0.17	0.577	0.19
☑ 1000524	*Planktothrix*	*isothrix*	.	.	.	.	Vegetative	2.142	4.40	163.098	53.17

Summary for Division ~ Cyanophyta (14 detail records) — **Sum Total Cyanophyta** — 15.655 — 32.16 — 266.296 — 86.81

Division: Miscellaneous

Taxa ID	Genus	Species	Subspecies	Variety	Form	Morph	Structure	Count **NU**/ml	Relative Count	Algal Cell Count **Cells**/ml	Relative Algal Cell Count
7140	*.	*spp*	.	.	.	Microflagellate	Vegetative	8.652	17.77	8.652	2.82

Summary for Division ~ Miscellaneous (1 detail record) — **Sum Total Miscellaneous** — 8.652 — 17.77 — 8.652 — 2.82

Division: Pyrrhophyta

Taxa ID	Genus	Species	Subspecies	Variety	Form	Morph	Structure	Count **NU**/ml	Relative Count	Algal Cell Count **Cells**/ml	Relative Algal Cell Count
6011	*Ceratium*	*hirundinella*	.	.	.	.	Vegetative	0.085	0.18	0.085	0.03

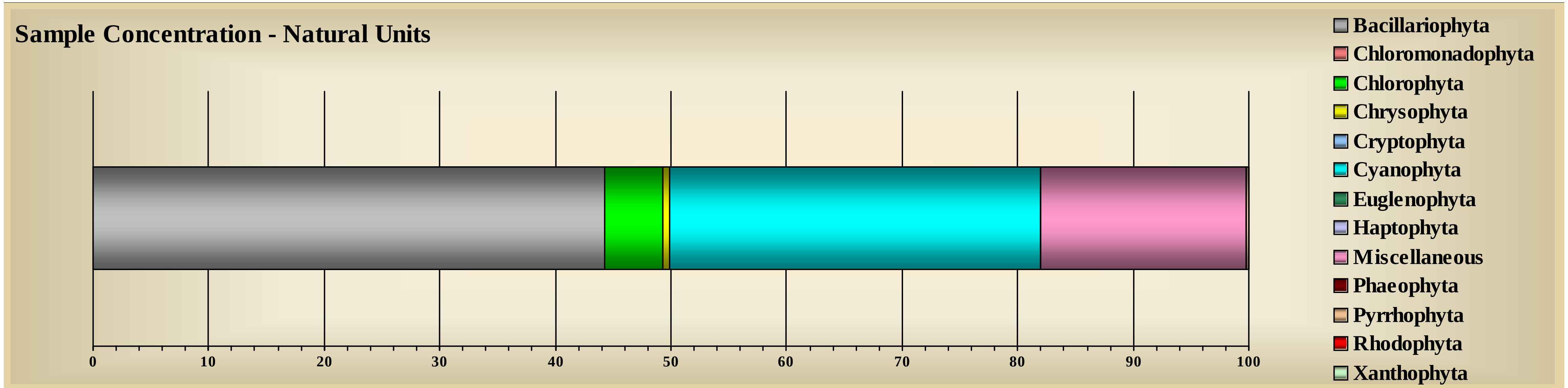
Summary for Division ~ Pyrrhophyta (1 detail record) — **Sum Total Pyrrhophyta** — 0.085 — 0.18 — 0.085 — 0.03

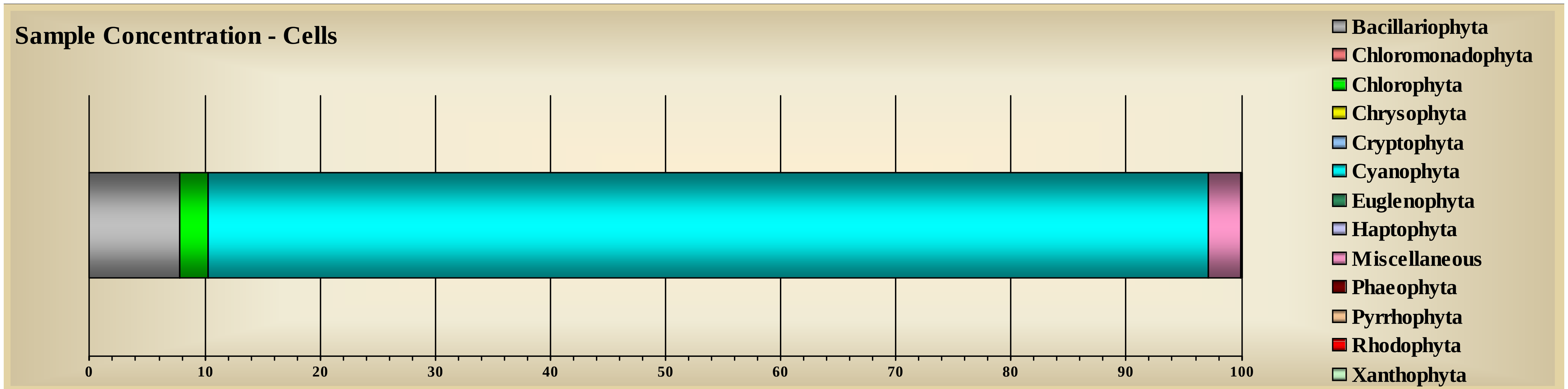
Division: Xanthophyta

Taxa ID	Genus	Species	Subspecies	Variety	Form	Morph	Structure	Count NU/ml	Relative Count	Algal Cell Count Cells/ml	Relative Algal Cell Count
1391	*Centratractus*	*belonophorus*	.	.	.	.	Vegetative	0.021	0.04	0.021	0.01
Summary for Division ~ Xanthophyta (1 detail record)						**Sum Total**	**Xanthophyta**	0.021	0.04	0.021	0.01

Total Sample Concentration	Total Sample Cell Concentration
48.683	306.748

SUMMARY GRAPHICS





Species List

Division: Bacillariophyta

Taxa ID	Genus	Species	Subspecies	Variety	Form	Morph	Structure	Authority
1000415	Rhizosolenia	longiseta	.	.	.	.	Vegetative	Zacharias 1893
1315	Synedra	ulna	.	.	.	.	Vegetative	(Nitzsch) Ehrenb.
1431	Aulacoseira	ambigua	.	.	.	.	Vegetative	(Grunow) Simonsen
1432	Aulacoseira	granulata	.	.	.	straight	Vegetative	(Ehrenb.) Simonsen
9212	Cocconeis	placentula	.	lineata	.	.	Vegetative	(Ehrenb.) Van Heurck
9363	Cyclotella	ocellata	.	.	.	.	Vegetative	Pant.
9504	Synedra	tenera	.	.	.	.	Vegetative	W. Sm.

Division: Chlorophyta

Taxa ID	Genus	Species	Subspecies	Variety	Form	Morph	Structure	Authority
2381	Pediastrum	spp	.	.	.	.	Vegetative	Meyen
1000012	Closterium	spp	.	.	.	.	Vegetative	.
1000072	Dictyosphaerium	chlorelloides	.	.	.	.	Vegetative	(Naumann) Komarek
2031	Ankistrodesmus	falcatus	.	.	.	monoraphidiod	Vegetative	(Corda) Ralfs
2035	Ankistrodesmus	convolutus	.	.	.	.	Vegetative	Corda
2080	Chlamydomonas	spp	.	.	.	.	Vegetative	Ehrenberg
2185	Cosmarium	tenue	.	.	.	.	Vegetative	Archer
2331	Micractinium	pusillum	.	.	.	.	Vegetative	Fresenius
2340	Mougeotia	spp	.	.	.	.	Vegetative	Kisselew
2363	Oocystis	parva	.	.	.	.	Vegetative	West & West
2367	Oocystis	pusilla	.	.	.	.	Vegetative	Hansgirg
2385	Pediastrum	simplex	.	.	.	.	Vegetative	Meyen Lemm
2462	Quadrigula	lacustris	.	.	.	.	Vegetative	(Chodat) G.M. Smith
2567	Tetraedron	regulare	.	incus	.	.	Vegetative	Kuetzing

2683	*Chlorococcaceae	spp	.	.	.	2-9.9 um spherical	Vegetative	N/A
2761	Phacotus	lendneri	.	.	.	.	Vegetative	Chodat
2853	Lagerheimia	quadriseta	.	.	.	.	Vegetative	(Lemmermann) G.M. Smith

Division: Chrysophyta

Taxa ID	Genus	Species	Subspecies	Variety	Form	Morph	Structure	Authority
1180	Mallomonas	spp	.	.	.	.	Vegetative	Perty

Division: Cyanophyta

Taxa ID	Genus	Species	Subspecies	Variety	Form	Morph	Structure	Authority
1000524	Planktothrix	isothrix	.	.	.	.	Vegetative	(Skuja) Komarek et Komarkova 2004
107576	Lyngbya	lagerheimia	.	minor	.	.	Vegetative	(Moebius) Gomont
4018	Anabaena	planctonica	.	.	.	.	Vegetative	Brunnthaler
4023	Cylindrospermopsis	raciborskii	.	.	.	straight	Vegetative	(Wolosz.) Seena. and Subbar.
4153	Lyngbya	limnetica	.	.	.	.	Vegetative	Lemmermann
4161	Merismopedia	tenuissima	.	.	.	.	Vegetative	Lemmermann
4183	Oscillatoria	agardhii	.	.	.	.	Vegetative	Gomont
4242	Gomphosphaeria	lacustris	.	.	.	.	Vegetative	Chod
4285	Synechocystis	spp	.	.	.	>1 um spherical	Vegetative	N/A
4321	Synechococcus	elongatus	.	.	.	.	Vegetative	Nageli
4331	Anabaena	macrospora	.	.	.	.	Vegetative	Klebahn 1895
4332	Anabaena	aphanizomenoides	.	.	.	.	Vegetative	Forti
4368	Oscillatoria	amphibia	.	.	.	.	Vegetative	Agardh
4421	Lyngbya	subtilis	.	.	.	.	Vegetative	West & West .

Division: Miscellaneous

Taxa ID	Genus	Species	Subspecies	Variety	Form	Morph	Structure	Authority
7140	*.	spp	.	.	.	Microflagellate	Vegetative	N/A

Division: Pyrrhophyta

Taxa ID	Genus	Species	Subspecies	Variety	Form	Morph	Structure	Authority
6011	Ceratium	hirundinella	.	.	.	.	Vegetative	Dujardin

Division: Xanthophyta

Taxa ID	Genus	Species	Subspecies	Variety	Form	Morph	Structure	Authority
1391	Centratractus	belonophorus	.	.	.	.	Vegetative	Lemmermann

APPENDIX V:

KOSCIUSKO COUNTY HEALTH DEPARTMENT –
HISTORICAL E COLI DATA FOR CENTER LAKE

CENTER LAKE E COLI DATA, MAY 1996 TO AUGUST 2003
KOSCIUSKO COUNTY HEALTH DEPARTMENT

Sampling Location, Number and Description		Date	E Coli (cfu/100mL)
1	West side of beach pier, approx. 40 feet from shore	05/22/1996	10
1	West side of beach pier, approx. 40 feet from shore	05/31/1996	20
1	West side of beach pier, approx. 40 feet from shore	06/03/1996	0
1	West side of beach pier, approx. 40 feet from shore	06/11/1996	20
1	West side of beach pier, approx. 40 feet from shore	06/17/1996	50
1	West side of beach pier, approx. 40 feet from shore	06/25/1996	0
1	West side of beach pier, approx. 40 feet from shore	07/09/1996	40
1	West side of beach pier, approx. 40 feet from shore	07/16/1996	90
1	West side of beach pier, approx. 40 feet from shore	07/23/1996	10
1	West side of beach pier, approx. 40 feet from shore	07/29/1996	0
1	West side of beach pier, approx. 40 feet from shore	08/05/1996	500
1	West side of beach pier, approx. 40 feet from shore	08/13/1996	10
1	West side of beach pier, approx. 40 feet from shore	08/15/1996	120
1	West side of beach pier, approx. 40 feet from shore	08/20/1996	0
1	West side of beach pier, approx. 40 feet from shore	08/28/1996	10
1	West side of beach pier, approx. 40 feet from shore	03/19/1997	0
1	West side of beach pier, approx. 40 feet from shore	04/02/1997	0
1	West side of beach pier, approx. 40 feet from shore	05/27/1997	0
1	West side of beach pier, approx. 40 feet from shore	06/09/1997	0
1	West side of beach pier, approx. 40 feet from shore	06/16/1997	0
1	West side of beach pier, approx. 40 feet from shore	06/23/1997	60
1	West side of beach pier, approx. 40 feet from shore	06/30/1997	110
1	West side of beach pier, approx. 40 feet from shore	07/03/1997	40
1	West side of beach pier, approx. 40 feet from shore	07/07/1997	10
1	West side of beach pier, approx. 40 feet from shore	07/21/1997	0
1	West side of beach pier, approx. 40 feet from shore	07/28/1997	62
1	West side of beach pier, approx. 40 feet from shore	08/04/1997	0
1	West side of beach pier, approx. 40 feet from shore	08/18/1997	60
1	West side of beach pier, approx. 40 feet from shore	09/03/1997	120
1	West side of beach pier, approx. 40 feet from shore	09/08/1997	210
1	West side of beach pier, approx. 40 feet from shore	09/15/1997	41
1	West side of beach pier, approx. 40 feet from shore	04/06/1998	0
1	West side of beach pier, approx. 40 feet from shore	04/20/1998	0
2	East side of beach pier, approx. 40 feet from shore	05/18/1998	20
1	West side of beach pier, approx. 40 feet from shore	5/18/1998	70
1	West side of beach pier, approx. 40 feet from shore	05/27/1998	370
2	East side of beach pier, approx. 40 feet from shore	05/27/1998	370
2	East side of beach pier, approx. 40 feet from shore	06/08/1998	0
1	West side of beach pier, approx. 40 feet from shore	06/08/1998	1,140
3	Terminal end of pier	06/12/1998	2,040

CENTER LAKE E COLI DATA, MAY 1996 TO AUGUST 2003
KOSCIUSKO COUNTY HEALTH DEPARTMENT

Sampling Location, Number and Description		Date	E Coli (cfu/100mL)
2	East side of beach pier, approx. 40 feet from shore	06/12/1998	60
1	West side of beach pier, approx. 40 feet from shore	06/12/1998	1,480
2	East side of beach pier, approx. 40 feet from shore	06/15/1998	245
1	West side of beach pier, approx. 40 feet from shore	06/15/1998	30
1	West side of beach pier, approx. 40 feet from shore	06/16/1998	1,650
3	Terminal end of pier	06/16/1998	550
2	East side of beach pier, approx. 40 feet from shore	06/16/1998	100
4	Near outfall from shore	06/16/1998	0
1	West side of beach pier, approx. 40 feet from shore	06/18/1998	0
2	East side of beach pier, approx. 40 feet from shore	06/18/1998	0
1	West side of beach pier, approx. 40 feet from shore	06/22/1998	70
2	East side of beach pier, approx. 40 feet from shore	06/22/1998	1,080
4	Near outfall from shore	06/29/1998	540
2	East side of beach pier, approx. 40 feet from shore	06/29/1998	40
1	West side of beach pier, approx. 40 feet from shore	06/29/1998	260
2	East side of beach pier, approx. 40 feet from shore	07/13/1998	30
1	West side of beach pier, approx. 40 feet from shore	07/13/1998	60
2	East side of beach pier, approx. 40 feet from shore	07/20/1998	50
1	West side of beach pier, approx. 40 feet from shore	07/20/1998	0
1	West side of beach pier, approx. 40 feet from shore	07/27/1998	440
2	East side of beach pier, approx. 40 feet from shore	07/27/1998	120
2	East side of beach pier, approx. 40 feet from shore	08/03/1998	65
1	West side of beach pier, approx. 40 feet from shore	08/03/1998	180
2	East side of beach pier, approx. 40 feet from shore	08/10/1998	65
1	West side of beach pier, approx. 40 feet from shore	08/10/1998	180
1	West side of beach pier, approx. 40 feet from shore	08/17/1998	440
2	East side of beach pier, approx. 40 feet from shore	08/17/1998	75
1	West side of beach pier, approx. 40 feet from shore	08/24/1998	500
2	East side of beach pier, approx. 40 feet from shore	08/24/1998	190
1	West side of beach pier, approx. 40 feet from shore	08/31/1998	140
2	East side of beach pier, approx. 40 feet from shore	08/31/1998	50
2	East side of beach pier, approx. 40 feet from shore	05/17/1999	5
1	West side of beach pier, approx. 40 feet from shore	05/17/1999	13
1	West side of beach pier, approx. 40 feet from shore	05/24/1999	23
2	East side of beach pier, approx. 40 feet from shore	05/24/1999	23
1	West side of beach pier, approx. 40 feet from shore	06/01/1999	200
2	East side of beach pier, approx. 40 feet from shore	06/01/1999	35
1	West side of beach pier, approx. 40 feet from shore	06/07/1999	50
2	East side of beach pier, approx. 40 feet from shore	06/07/1999	2
1	West side of beach pier, approx. 40 feet from shore	06/14/1999	190
2	East side of beach pier, approx. 40 feet from shore	06/14/1999	0
1	West side of beach pier, approx. 40 feet from shore	06/21/1999	12
2	East side of beach pier, approx. 40 feet from shore	06/21/1999	14

CENTER LAKE E COLI DATA, MAY 1996 TO AUGUST 2003
KOSCIUSKO COUNTY HEALTH DEPARTMENT

Sampling Location, Number and Description		Date	E Coli (cfu/100mL)
2	East side of beach pier, approx. 40 feet from shore	06/28/1999	63
1	West side of beach pier, approx. 40 feet from shore	06/28/1999	89
2	East side of beach pier, approx. 40 feet from shore	07/06/1999	25
1	West side of beach pier, approx. 40 feet from shore	07/06/1999	66
1	West side of beach pier, approx. 40 feet from shore	07/13/1999	2
2	East side of beach pier, approx. 40 feet from shore	07/13/1999	6
2	East side of beach pier, approx. 40 feet from shore	07/19/1999	17
1	West side of beach pier, approx. 40 feet from shore	07/19/1999	120
1	West side of beach pier, approx. 40 feet from shore	07/26/1999	120
2	East side of beach pier, approx. 40 feet from shore	07/26/1999	43
1	West side of beach pier, approx. 40 feet from shore	08/02/1999	14
2	East side of beach pier, approx. 40 feet from shore	08/02/1999	13
1	West side of beach pier, approx. 40 feet from shore	08/09/1999	14
2	East side of beach pier, approx. 40 feet from shore	08/09/1999	23
2	East side of beach pier, approx. 40 feet from shore	08/17/1999	20
1	West side of beach pier, approx. 40 feet from shore	08/17/1999	285
1	West side of beach pier, approx. 40 feet from shore	08/30/1999	3
2	East side of beach pier, approx. 40 feet from shore	08/30/1999	10
1	West side of beach pier, approx. 40 feet from shore	09/07/1999	11
2	East side of beach pier, approx. 40 feet from shore	09/07/1999	15
2	East side of beach pier, approx. 40 feet from shore	05/22/2000	15
1	West side of beach pier, approx. 40 feet from shore	05/22/2000	360
2	East side of beach pier, approx. 40 feet from shore	05/22/2000	12
1	West side of beach pier, approx. 40 feet from shore	05/30/2000	2,400
2	East side of beach pier, approx. 40 feet from shore	06/05/2000	5
1	West side of beach pier, approx. 40 feet from shore	06/05/2000	78
1	West side of beach pier, approx. 40 feet from shore	06/07/2000	115
2	East side of beach pier, approx. 40 feet from shore	06/07/2000	20
2	East side of beach pier, approx. 40 feet from shore	06/12/2000	1
1	West side of beach pier, approx. 40 feet from shore	06/12/2000	0
2	East side of beach pier, approx. 40 feet from shore	06/19/2000	2
1	West side of beach pier, approx. 40 feet from shore	06/19/2000	4
1	West side of beach pier, approx. 40 feet from shore	06/26/2000	29
2	East side of beach pier, approx. 40 feet from shore	06/26/2000	7
2	East side of beach pier, approx. 40 feet from shore	07/05/2000	30
1	West side of beach pier, approx. 40 feet from shore	07/05/2000	200
2	East side of beach pier, approx. 40 feet from shore	07/10/2000	0
1	West side of beach pier, approx. 40 feet from shore	07/10/2000	3
2	East side of beach pier, approx. 40 feet from shore	07/17/2000	6
1	West side of beach pier, approx. 40 feet from shore	07/17/2000	5
2	East side of beach pier, approx. 40 feet from shore	07/24/2000	31
1	West side of beach pier, approx. 40 feet from shore	07/24/2000	4
2	East side of beach pier, approx. 40 feet from shore	07/31/2000	15

CENTER LAKE E COLI DATA, MAY 1996 TO AUGUST 2003
KOSCIUSKO COUNTY HEALTH DEPARTMENT

Sampling Location, Number and Description		Date	E Coli (cfu/100mL)
1	West side of beach pier, approx. 40 feet from shore	07/31/2000	0
2	East side of beach pier, approx. 40 feet from shore	08/07/2000	42
1	West side of beach pier, approx. 40 feet from shore	08/07/2000	610
2	East side of beach pier, approx. 40 feet from shore	08/10/2000	52
1	West side of beach pier, approx. 40 feet from shore	08/14/2000	1,600
2	East side of beach pier, approx. 40 feet from shore	08/18/2000	120
1	West side of beach pier, approx. 40 feet from shore	08/18/2000	100
1	West side of beach pier, approx. 40 feet from shore	08/21/2000	35
2	East side of beach pier, approx. 40 feet from shore	08/21/2000	52
1	West side of beach pier, approx. 40 feet from shore	08/28/2000	120
2	East side of beach pier, approx. 40 feet from shore	08/28/2000	730
2	East side of beach pier, approx. 40 feet from shore	05/14/2001	2
1	West side of beach pier, approx. 40 feet from shore	05/14/2001	7
2	East side of beach pier, approx. 40 feet from shore	05/21/2001	24
1	West side of beach pier, approx. 40 feet from shore	05/21/2001	6
2	East side of beach pier, approx. 40 feet from shore	05/29/2001	40
1	West side of beach pier, approx. 40 feet from shore	05/29/2001	20
1	West side of beach pier, approx. 40 feet from shore	06/11/2001	0
2	East side of beach pier, approx. 40 feet from shore	06/11/2001	0
2	East side of beach pier, approx. 40 feet from shore	06/18/2001	60
1	West side of beach pier, approx. 40 feet from shore	06/18/2001	60
1	West side of beach pier, approx. 40 feet from shore	06/25/2001	10
2	East side of beach pier, approx. 40 feet from shore	06/25/2001	20
1	West side of beach pier, approx. 40 feet from shore	07/02/2001	10
2	East side of beach pier, approx. 40 feet from shore	07/02/2001	10
1	West side of beach pier, approx. 40 feet from shore	07/09/2001	340
2	East side of beach pier, approx. 40 feet from shore	07/09/2001	50
2	East side of beach pier, approx. 40 feet from shore	07/10/2001	30
1	West side of beach pier, approx. 40 feet from shore	07/10/2001	40
2	East side of beach pier, approx. 40 feet from shore	07/16/2001	0
1	West side of beach pier, approx. 40 feet from shore	07/16/2001	100
2	East side of beach pier, approx. 40 feet from shore	07/24/2001	10
1	West side of beach pier, approx. 40 feet from shore	07/24/2001	150
2	East side of beach pier, approx. 40 feet from shore	08/01/2001	40
1	West side of beach pier, approx. 40 feet from shore	08/01/2001	30
1	West side of beach pier, approx. 40 feet from shore	08/06/2001	0
2	East side of beach pier, approx. 40 feet from shore	08/06/2001	90
1	West side of beach pier, approx. 40 feet from shore	08/13/2001	10
2	East side of beach pier, approx. 40 feet from shore	08/13/2001	160
2	East side of beach pier, approx. 40 feet from shore	08/20/2001	40
1	West side of beach pier, approx. 40 feet from shore	08/20/2001	130
2	East side of beach pier, approx. 40 feet from shore	08/27/2001	20
1	West side of beach pier, approx. 40 feet from shore	08/27/2001	30

CENTER LAKE E COLI DATA, MAY 1996 TO AUGUST 2003
KOSCIUSKO COUNTY HEALTH DEPARTMENT

Sampling Location, Number and Description		Date	E Coli (cfu/100mL)
2	East side of beach pier, approx. 40 feet from shore	05/23/2002	30
1	West side of beach pier, approx. 40 feet from shore	05/23/2002	140
2	East side of beach pier, approx. 40 feet from shore	05/28/2002	20
1	West side of beach pier, approx. 40 feet from shore	05/28/2002	1,100
2	East side of beach pier, approx. 40 feet from shore	06/03/2002	40
1	West side of beach pier, approx. 40 feet from shore	06/03/2002	40
2	East side of beach pier, approx. 40 feet from shore	06/10/2002	20
1	West side of beach pier, approx. 40 feet from shore	06/10/2002	220
2	East side of beach pier, approx. 40 feet from shore	06/17/2002	0
1	West side of beach pier, approx. 40 feet from shore	06/17/2002	70
1	West side of beach pier, approx. 40 feet from shore	06/24/2002	0
2	East side of beach pier, approx. 40 feet from shore	06/24/2002	20
1	West side of beach pier, approx. 40 feet from shore	07/01/2002	30
2	East side of beach pier, approx. 40 feet from shore	07/01/2002	40
2	East side of beach pier, approx. 40 feet from shore	07/08/2002	50
1	West side of beach pier, approx. 40 feet from shore	07/08/2002	50
1	West side of beach pier, approx. 40 feet from shore	07/15/2002	30
2	East side of beach pier, approx. 40 feet from shore	07/15/2002	0
2	East side of beach pier, approx. 40 feet from shore	07/22/2002	120
1	West side of beach pier, approx. 40 feet from shore	07/22/2002	500
2	East side of beach pier, approx. 40 feet from shore	07/29/2002	70
1	West side of beach pier, approx. 40 feet from shore	07/29/2002	160
2	East side of beach pier, approx. 40 feet from shore	08/05/2002	500
1	West side of beach pier, approx. 40 feet from shore	08/05/2002	130
2	East side of beach pier, approx. 40 feet from shore	08/12/2002	0
1	West side of beach pier, approx. 40 feet from shore	08/12/2002	30
1	West side of beach pier, approx. 40 feet from shore	08/19/2002	460
2	East side of beach pier, approx. 40 feet from shore	08/19/2002	510
1	West side of beach pier, approx. 40 feet from shore	08/26/2002	110
2	East side of beach pier, approx. 40 feet from shore	08/26/2002	100
1	West side of beach pier, approx. 40 feet from shore	05/27/2003	31.8
2	East side of beach pier, approx. 40 feet from shore	05/27/2003	0
1	West side of beach pier, approx. 40 feet from shore	06/02/2003	111.2
2	East side of beach pier, approx. 40 feet from shore	06/02/2003	6.3
2	East side of beach pier, approx. 40 feet from shore	06/09/2003	2
1	West side of beach pier, approx. 40 feet from shore	06/09/2003	727
2	East side of beach pier, approx. 40 feet from shore	06/16/2003	58.1
1	West side of beach pier, approx. 40 feet from shore	06/16/2003	21.6
1	West side of beach pier, approx. 40 feet from shore	06/23/2003	35
2	East side of beach pier, approx. 40 feet from shore	06/23/2003	11
1	West side of beach pier, approx. 40 feet from shore	06/30/2003	579.4
2	East side of beach pier, approx. 40 feet from shore	06/30/2003	69.7
1	West side of beach pier, approx. 40 feet from shore	07/07/2003	517.2

CENTER LAKE E COLI DATA, MAY 1996 TO AUGUST 2003
KOSCIUSKO COUNTY HEALTH DEPARTMENT

Sampling Location, Number and Description		Date	E Coli (cfu/100mL)
2	East side of beach pier, approx. 40 feet from shore	07/07/2003	461.1
1	West side of beach pier, approx. 40 feet from shore	07/08/2003	770.1
2	East side of beach pier, approx. 40 feet from shore	07/08/2003	2,419.2
2	East side of beach pier, approx. 40 feet from shore	07/14/2003	63.1
1	West side of beach pier, approx. 40 feet from shore	07/14/2003	36.4
2	East side of beach pier, approx. 40 feet from shore	07/21/2003	387.3
1	West side of beach pier, approx. 40 feet from shore	07/21/2003	387.3
2	East side of beach pier, approx. 40 feet from shore	07/22/2003	93.2
1	West side of beach pier, approx. 40 feet from shore	07/22/2003	261.3
2	East side of beach pier, approx. 40 feet from shore	07/28/2003	186
1	West side of beach pier, approx. 40 feet from shore	07/28/2003	123.6
1	West side of beach pier, approx. 40 feet from shore	08/04/2003	172.3
2	East side of beach pier, approx. 40 feet from shore	08/04/2003	75.2
1	West side of beach pier, approx. 40 feet from shore	08/11/2003	76.8
2	East side of beach pier, approx. 40 feet from shore	08/11/2003	28.8
1	West side of beach pier, approx. 40 feet from shore	08/18/2003	27.5
2	East side of beach pier, approx. 40 feet from shore	08/18/2003	69.7

APPENDIX VI:

HABITAT AND MICROINVERTEBRATE DATA SHEETS AND SAMPLING STATION PHOTOGRAPHS

HABITAT ASSESSMENT FIELD DATA SHEET—LOW GRADIENT STREAMS (FRONT)

STREAM NAME Tippecanoe River	LOCATION 300 N
STATION # ________ RIVERMILE ________	STREAM CLASS
LAT ________ LONG ________	RIVER BASIN
STORET #	AGENCY
INVESTIGATORS EJB/NRI	
FORM COMPLETED BY	DATE 8/21/03 TIME ________ AM PM
	REASON FOR SURVEY

Parameters to be evaluated in sampling reach

Habitat Parameter	Condition Category			
	Optimal	Suboptimal	Marginal	Poor
1. Epifaunal Substrate/ Available Cover	Greater than 50% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are <u>not</u> new fall and <u>not</u> transient).	30-50% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale).	10-30% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 10% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
SCORE				
2. Pool Substrate Characterization	Mixture of substrate materials, with gravel and firm sand prevalent; root mats and submerged vegetation common.	Mixture of soft sand, mud, or clay; mud may be dominant; some root mats and submerged vegetation present.	All mud or clay or sand bottom; little or no root mat; no submerged vegetation.	Hard-pan clay or bedrock; no root mat or vegetation.
SCORE				
3. Pool Variability	Even mix of large-shallow, large-deep, small-shallow, small-deep pools present.	Majority of pools large-deep; very few shallow.	Shallow pools much more prevalent than deep pools.	Majority of pools small-shallow or pools absent.
SCORE				
4. Sediment Deposition	Little or no enlargement of islands or point bars and less than <20% of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 20-50% of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 50-80% of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 80% of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
SCORE				
5. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or <25% of channel substrate is exposed.	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
SCORE				

Tippecanoe River

HABITAT ASSESSMENT FIELD DATA SHEET—LOW GRADIENT STREAMS (BACK)

Parameters to be evaluated broader than sampling reach

Habitat Parameter	Condition Category			
	Optimal	Suboptimal	Marginal	Poor
6. Channel Alteration	Channelization or dredging absent or minimal; stream with normal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.
SCORE				
7. Channel Sinuosity	The bends in the stream increase the stream length 3 to 4 times longer than if it was in a straight line. (Note - channel braiding is considered normal in coastal plains and other low-lying areas. This parameter is not easily rated in these areas.)	The bends in the stream increase the stream length 1 to 2 times longer than if it was in a straight line.	The bends in the stream increase the stream length 1 to 2 times longer than if it was in a straight line.	Channel straight; waterway has been channelized for a long distance.
SCORE				
8. Bank Stability (score each bank)	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
SCORE ___ (LB)				
SCORE ___ (RB)				
9. Vegetative Protection (score each bank) Note: determine left or right side by facing downstream.	More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.
SCORE ___ (LB)				
SCORE ___ (RB)				
10. Riparian Vegetative Zone Width (score each bank riparian zone)	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.	Width of riparian zone <6 meters: little or no riparian vegetation due to human activities.
SCORE ___ (LB)				
SCORE ___ (RB)				

Total Score 127

OhioEPA Qualitative Habitat Evaluation Index Field Sheet QHEI Score:

River Code: ______ RM: ______ Stream: Tippecanoe River
Date: 8/21/03 Location: 500 North
Scorers Full Name: ______ Affiliation: ______

1] SUBSTRATE (Check ONLY Two Substrate TYPE BOXES; Estimate % present

TYPE	POOL	RIFFLE	TYPE	POOL	RIFFLE
BLDR /SLBS[10]			GRAVEL [7] (X)	95	5
BOULDER [9]			SAND [6] (X)	95	5
COBBLE [8]			BEDROCK[5]		
HARDPAN [4]			DETRITUS[3]		
MUCK [2]			ARTIFICIAL[0]		
SILT [2]					

NOTE: Ignore Sludge Originating From Point Sources

SUBSTRATE ORIGIN
Check ONE (OR 2 & AVERAGE)
- LIMESTONE [1]
- TILLS [1]
- X WETLANDS[0]
- HARDPAN [0]
- SANDSTONE [0]
- RIP/RAP [0]
- LACUSTRINE [0]
- SHALE [-1]
- COAL FINES [-2]

SUBSTRATE QUALITY
Check ONE (OR 2 & AVERAGE)

SILT:
- SILT HEAVY [-2]
- SILT MODERATE [-1]
- X SILT NORMAL [0]
- SILT FREE [1]

EMBEDDEDNESS:
- EXTENSIVE [-2]
- MODERATE [-1]
- X NORMAL [0]
- NONE [1]

NUMBER OF SUBSTRATE TYPES: (High Quality Only, Score 5 or >)
- X 4 or More [2]
- 3 or Less [0]

COMMENTS ______

Substrate: 15 (Max 20)

2] INSTREAM COVER (Give each cover type a score of 0 to 3; see back for instructions)
(Structure) TYPE: Score All That Occur

- X UNDERCUT BANKS [1]
- X OVERHANGING VEGETATION [1]
- X SHALLOWS (IN SLOW WATER) [1]
- X ROOTMATS [1]
- X POOLS> 70 cm [2]
- X ROOTWADS [1]
- ___ BOULDERS [1]
- X OXBOWS, BACKWATERS [1]
- ___ AQUATIC MACROPHYTES [1]
- X LOGS OR WOODY DEBRIS [1]

COMMENTS: ______

AMOUNT: (Check ONLY One or check 2 and AVERAGE)
- EXTENSIVE > 75% [11]
- X MODERATE 25-75% [7]
- SPARSE 5-25% [3]
- NEARLY ABSENT < 5%[1]

Cover: 16 (Max 20)

3] CHANNEL MORPHOLOGY: (Check ONLY One PER Category OR check 2 and AVERAGE)

SINUOSITY
- HIGH [4]
- X MODERATE [3]
- LOW [2]
- NONE [1]

DEVELOPMENT
- EXCELLENT [7]
- X GOOD [5]
- FAIR [3]
- POOR [1]

CHANNELIZATION
- X NONE [6]
- RECOVERED [4]
- RECOVERING [3]
- RECENT OR NO RECOVERY [1]

STABILITY
- HIGH [3]
- X MODERATE [2]
- LOW [1]

MODIFICATIONS/OTHER
- SNAGGING
- RELOCATION
- CANOPY REMOVAL
- DREDGING
- ONE SIDE CHANNEL MODIFICATIONS
- IMPOUND.
- ISLANDS
- LEVEED
- BANK SHAPING

COMMENTS: ______

Channel: 16 (Max 20)

4]. RIPARIAN ZONE AND BANK EROSION (check ONE box per bank or check 2 and AVERAGE per bank) River Right Looking Downstream

RIPARIAN WIDTH
L R (Per Bank)
- R: X WIDE > 50m [4]
- MODERATE 10-50m [3]
- NARROW 5-10 m [2]
- L: X VERY NARROW < 5 m[1]
- NONE [0]

FLOOD PLAIN QUALITY (PAST 100 Meter RIPARIAN)
L R (Most Predominant Per Bank)
- R: X FOREST, SWAMP [3]
- SHRUB OR OLD FIELD [2]
- L: X RESIDENTIAL, PARK, NEW FIELD [1]
- FENCED PASTURE [1]

L R
- CONSERVATION TILLAGE [1]
- URBAN OR INDUSTRIAL [0]
- OPEN PASTURE, ROWCROP [0]
- MINING/CONSTRUCTION [0]

BANK EROSION
L R (Per Bank)
- NONE/LITTLE [3]
- L, R: X X MODERATE [2]
- HEAVY/SEVERE[1]

COMMENTS: ______

Riparian: 6.5 (Max 10)

5.]POOL/GLIDE AND RIFFLE/RUN QUALITY

MAX. DEPTH (Check 1 ONLY!)
- >1m [6]
- X 0.7-1m [4]
- 0.4-0.7m [2]
- 0.2-0.4m [1]
- < 0.2m [POOL=0]

MORPHOLOGY (Check 1 or 2 & AVERAGE)
- X POOL WIDTH > RIFFLE WIDTH [2]
- POOL WIDTH = RIFFLE WIDTH [1]
- POOL WIDTH < RIFFLE W. [0]

CURRENT VELOCITY [POOLS & RIFFLES!] (Check All That Apply)
- EDDIES[1]
- FAST[1]
- X MODERATE [1]
- SLOW [1]
- TORRENTIAL[-1]
- INTERSTITIAL[-1]
- INTERMITTENT[-2]
- VERY FAST[1]

COMMENTS: ______

Pool/Current: 7 (Max 12)

CHECK ONE OR CHECK 2 AND AVERAGE

RIFFLE DEPTH
- Best Areas >10 cm [2]
- X Best Areas 5-10 cm[1]
- X Best Areas < 5 cm [RIFFLE=0]

RUN DEPTH
- MAX > 50 [2]
- X MAX < 50[1]

RIFFLE/RUN SUBSTRATE
- STABLE (e.g.,Cobble, Boulder) [2]
- MOD. STABLE (e.g.,Large Gravel) [1]
- X UNSTABLE (Fine Gravel,Sand) [0]

RIFFLE/RUN EMBEDDEDNESS
- NONE [2]
- LOW [1]
- X MODERATE [0]
- EXTENSIVE [-1]

COMMENTS: ______ NO RIFFLE [Metric=0]

Riffle/Run: 2 (Max 8)

Gradient: (Max 10)

6] GRADIENT (ft/mi): ______ DRAINAGE AREA (sq.mi.) : ______

%POOL: ______ %GLIDE: ______
%RIFFLE: ______ %RUN: ______

*' Best areas must be large enough to support a population of riffle-obligate species

EPA 4520 06/24/01

PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET (FRONT)

STREAM NAME Tippecanoe River	LOCATION 300 N
STATION #____ RIVERMILE____	STREAM CLASS
LAT ____ LONG ____	RIVER BASIN
STORET #	AGENCY
INVESTIGATORS EDB/NRT	
FORM COMPLETED BY	DATE 8/21/03 TIME 1020 AM PM — REASON FOR SURVEY CARE STUDY

WEATHER CONDITIONS

Now		Past 24 hours
☐	storm (heavy rain)	☐
☐	rain (steady rain)	☐
☐	showers (intermittent)	☐
__%☐	%cloud cover	☐__%
☒	clear/sunny	☐

Has there been a heavy rain in the last 7 days? ☐ Yes ☒ No

Air Temperature 85 °F or 29.5°C

Other____

SITE LOCATION/MAP

Draw a map of the site and indicate the areas sampled (or attach a photograph)

Upstream and Downstream Facing Photos are attached

STREAM CHARACTERIZATION

Stream Subsystem
☒ Perennial ☐ Intermittent ☐ Tidal

Stream Origin
☐ Glacial
☐ Non-glacial montane
☐ Swamp and bog
☐ Spring-fed
☒ Mixture of origins
☐ Other____

Stream Type
☐ Coldwater ☒ Warmwater

Catchment Area____km²

Tippecanoe River

PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET (BACK)

WATERSHED FEATURES	**Predominant Surrounding Landuse** ☒ Forest ☐ Commercial ☐ Field/Pasture ☐ Industrial ☐ Agricultural ☐ Other ____ ☒ Residential **Local Watershed NPS Pollution** ☒ No evidence ☐ Some potential sources ☐ Obvious sources **Local Watershed Erosion** ☐ None ☒ Moderate ☐ Heavy
RIPARIAN VEGETATION (18 meter buffer)	**Indicate the dominant type and record the dominant species present** ☒ Trees ☒ Shrubs ☒ Grasses ☒ Herbaceous **dominant species present** ____
INSTREAM FEATURES	**Estimated Reach Length** 100 m **Estimated Stream Width** 15 m **Sampling Reach Area** ____ m² **Area in km² (m²x1000)** ____ km² **Estimated Stream Depth** 1 m **Surface Velocity (at thalweg)** .3 m/sec **Canopy Cover** ☐ Partly open ☐ Partly shaded ☒ Shaded **High Water Mark** 2 m **Proportion of Reach Represented by Stream Morphology Types** ☒ Riffle 5 % ☒ Run 20 % ☒ Pool 75 % **Channelized** ☐ Yes ☒ No **Dam Present** ☐ Yes ☒ No
LARGE WOODY DEBRIS	**LWD** 10 m² **Density of LWD** ____ m²/km² (LWD/ reach area)
AQUATIC VEGETATION	**Indicate the dominant type and record the dominant species present** ☐ Rooted emergent ☐ Rooted submergent ☐ Rooted floating ☐ Free floating ☐ Floating Algae ☒ Attached Algae **dominant species present** ____ **Portion of the reach with aquatic vegetation** 1 %
WATER QUALITY	**Temperature** ____ °C 73.8 F ~~**Specific Conductance**~~ Conductivity 485.6 **Dissolved Oxygen** 7068 **pH** 8.25 **Turbidity** 1.59 **WQ Instrument Used** ____ ORP = 1169 **Water Odors** ☒ Normal/None ☐ Sewage ☐ Petroleum ☐ Chemical ☐ Fishy ☐ Other ____ **Water Surface Oils** ☐ Slick ☐ Sheen ☐ Globs ☐ Flecks ☒ None ☐ Other ____ **Turbidity (if not measured)** ☒ Clear ☐ Slightly turbid ☐ Turbid ☐ Opaque ☐ Stained ☐ Other ____
SEDIMENT/ SUBSTRATE	**Odors** ☒ Normal ☐ Sewage ☐ Petroleum ☐ Chemical ☐ Anaerobic ☐ None ☐ Other ____ **Oils** ☒ Absent ☐ Slight ☐ Moderate ☐ Profuse **Deposits** ☐ Sludge ☐ Sawdust ☐ Paper fiber ☒ Sand ☐ Relict shells ☐ Other ____ **Looking at stones which are not deeply embedded, are the undersides black in color?** ☐ Yes ☒ No

INORGANIC SUBSTRATE COMPONENTS (should add up to 100%)			ORGANIC SUBSTRATE COMPONENTS (does not necessarily add up to 100%)		
Substrate Type	**Diameter**	**% Composition in Sampling Reach**	**Substrate Type**	**Characteristic**	**% Composition in Sampling Area**
Bedrock			Detritus	sticks, wood, coarse plant materials (CPOM)	10%
Boulder	> 256 mm (10")				
Cobble	64-256 mm (2.5"-10")	5	Muck-Mud	black, very fine organic (FPOM)	—
Gravel	2-64 mm (0.1"-2.5")	55			
Sand	0.06-2mm (gritty)	35	Marl	grey, shell fragments	—
Silt	0.004-0.06 mm	5			
Clay	< 0.004 mm (slick)				

BENTHIC MACROINVERTEBRATE LABORATORY BENCH SHEET (FRONT)

page ____ of ____

STREAM NAME Tippecanoe River	LOCATION 300N
STATION # ______ RIVERMILE ______	STREAM CLASS
LAT ______ LONG ______	RIVER BASIN
STORET #	AGENCY
COLLECTED BY EJB/NRT DATE 8/21/03	LOT #
TAXONOMIST EJB DATE ______	SUBSAMPLE TARGET ☐ 100 ☐ 200 ☐ 300 ☐ Other ____

Enter Family and/or Genus and Species name on blank line.

	Organisms		No.	LS	TI	TCR
1	Oligochaeta	I	1	A	EJB	1
	Hirudinea					
	Isopoda					
11	Amphipoda shrimp	~~||||~~ ~~||||~~ I	11	A	EJB	1
1	Decapoda crayfish	I	1	A	EJB	1
Mayfly 14	Ephemeroptera	Siphlonuridae Ameletus ~~||||~~ ~~||||~~ IIII	14	I	EJB	2
	BAETID	Baetidae Baetis I	1	I	EJB	1
7	Caenidae	Caenidae genus ~~||||~~ II	7	I	EJB	1
29	Heptageniidae	IIII Stenonema ~~||||~~ ~~||||~~ ~~||||~~ ~~||||~~ ~~||||~~	29	I	EJB	1
	Plecoptera Stonefly					
21	Trichoptera Caddisfly HYDRO	Hydropsychinae Hydropsyche ~~||||~~ ~~||||~~ ~~||||~~ ~~||||~~ I	21	[illegible]	EJB	1
3	SAERDFNS	III Brachycentridae Brachycentrus	3	I	EJB	1
8	HELISO	II Helicopsyche	2	I	EJB	1
6	OTHER	~~||||~~ I Limnephilidae	6	I/P	EJB	1
1		Leptoceridae Oecetis	1	I	EJB	1
	Hemiptera True Bugs					

Organisms		No.	LS	TI	TCR	
Megaloptera	I Corydalus Latreille Corydalidae	1	I	EJB	1	1
Coleoptera Beetle	Hydrophilidae	12	A	EJB	1	12 Short Antenna
	Elmidae	2	A	EJB	1	2 Long Antenna
WATER PENNY	IIII Psephenidae	4	A	EJB	1	4 Water Penny
larva	Gyrinidae	2	I	EJB	1	2
Diptera True Flies	Elmidae	2	I	EJB	1	
Brown	~~||||~~ I Chironomidae	6	I	EJB	1	6
Gastropoda Snail / Physa Right Hand	II Physidae	2	A	[illegible]	1	1
	~~||||~~ ~~||||~~ ~~||||~~ I Lymnaeidae	16	A	[illegible]	2	2
Pelecypoda Clams Mussels	Rainbow Villosa iris	1	A	EJB	1	1
	Corbicula	3	A	EJB	1	3
	[illegible]	~~2~~	~~A~~	~~EJB~~		
Other Zebra Mussle	Dreissena polymorpha	1	A	EJB	1	1
ANISOPT	I Gomphidae Hagenius	1	A	EJB	1	1

Taxonomic certainty rating (TCR) 1-5:1=most certain, 5=least certain. If rating is 3-5, give reason (e.g., missing gills). LS= life stage: I = immature; P = pupa; A = adult TI = Taxonomists initials

Total No. Organisms ______________ **Total No. Taxa** ______________

Center Lake Diagnostic Study - August 21, 2003 - Tippecanoe River, north of and adjacent to 300 N

Macrobenthos Qualitative Sample List

Vial #	ORDER	FAMILY	GENUS	SPECIES	COUNT	TOLERANCE VALUES	FBI
	Nematomorpha						0.000
	Tubellaria	Planaria				4	0.000
	Porifera	Spongillidae					0.000
	Pelecypoda	Corbiculidae	Corbicula	fluminea	3		0.000
		Lampsilinae	Villosa	iris	1		0.000
		Dreissenidae	Dreissena	polymorpha	1		0.000
		Sphaeriidae					0.000
	Gastropoda	Ancylidae				6	0.000
		Lymnaeidae	Fossaria		16	6	0.727
		Physidae	Physella		2	8	0.121
		Planorbidae				7	0.000
		Planorbidae	Planorbula			7	0.000
		Bithyniidae	Bithynia	tentaculata			0.000
	Annelid	Hirudinea				10	0.000
	Oligochaeta				1		0.000
	Decapoda				1	8	0.061
	Amphipoda				11	4	0.333
	Isopoda	Asellidae				8	0.000
	Ostracoda					8	0.000
	Ephemeroptera	Caenidae	Caenis		7	7	0.371
		Ephemeridae	Hexagenia			3.6	0.000
12		Baetidae	Baetis		1	4	0.030
		Baetidae	Baetis	intercalaris		2.7	0.000
		Baetidae	Callibaetis			5.6	0.000
		Heptageniidae	Stenacron	gildersleevei		3.1	0.000
10		Heptageniidae	Stenonema		29	4	0.879
11		Siphlonuridae	Ameletus		14	7	0.742
		Ephemerellidae	Timpanoga			1	0.000
		Leptophlebiidae				2	0.000
	Coleoptera	Dytiscidae				5	0.000
		Gyrinidae			2	5	0.076
		Haliplidae				7	0.000
		Dryopidae				5	0.000
		Elmidae			4	4	0.121
		Psephenidae	Psephenus		4	4	0.121
		Hydrophiloidae					0.000
		Hydrophilidae			12		0.000
	Megaloptera	Sialidae				4	0.000
		Corydalidae	Corydalus		1	4	0.030
14	Trichoptera	Brachycentridae	Brachycentrus		3	1	0.023
13		Helicopsychidae	Helicopsyche		2	3	0.045
		Hydropsychidae	Hydropsyche			4	0.000
9		Hydropsychidae	Hydropsyche		21	4	0.636
		Hydroptilidae				4	0.000
		Hydroptilidae	Hydroptila			3.2	0.000
		Leptoceridae	Nectopsyche			4	0.000
16		Leptoceridae	Oecetis		1	3	0.023
15		Limnephilidae			6	4	0.182
		Molannidae				6	0.000
		Philopotamidae				3	0.000
		Phryganeidae	Hagenella			4	0.000
		Polycentropodidae	Cymellus			6	0.000
		Psychomyiidae	Lype			2	0.000
	Hemiptera	Belostomatidae					0.000
		Corixidae				10	0.000
		Gerridae				5	0.000
		Nepidae					0.000
	Plecoptera	Perlidae	Perlesta			1	0.000
	Anisoptera	Aeshnidae				3	0.000
		Gomphidae	Hagenius		1	1	0.008
		Cordulegastridae				3	0.000
		Corduliidae				5	0.000
		Libellulidae				9	0.000
	Zygoptera	Calopterygidae				5	0.000
		Calopterygidae	Calopteryx			3.7	0.000
		Coenagrionidae				6.1	0.000
		Coenagrionidae	Argia			5.1	0.000
		Lestidae				9	0.000
	Diptera	Ceratopogonidae				6	0.000
		Blood-red Chironomidae				10	0.000
		Other Chironomidae			6	6	0.273
		Culicidae				8	0.000
		Simuliidae				6	0.000
		Tipulidae				3	0.000
		Stratiomyidae				8	0.000
		Tabanidae				6	0.000

TAXA RICHNESS	24
FBI	4.803
Scraper/Filter	1.828
EPT/Chironomidae	14.000
% Contribution of Domir	0.193
EPT Index	9.000
Community Similarity Indices	
CPOM	
Total Number Collected	150
total shredders	12

Lones Ditch

HABITAT ASSESSMENT FIELD DATA SHEET—LOW GRADIENT STREAMS (FRONT)

STREAM NAME Pike Lake Outlet	LOCATION Warsaw, IND
STATION #________ RIVERMILE________	STREAM CLASS
LAT____________ LONG____________	RIVER BASIN
STORET #	AGENCY
INVESTIGATORS EDB, NRT	
FORM COMPLETED BY	DATE ________ TIME ________ AM PM / REASON FOR SURVEY

Parameters to be evaluated in sampling reach

Habitat Parameter	Condition Category			
	Optimal	Suboptimal	Marginal	Poor
1. Epifaunal Substrate/ Available Cover	Greater than 50% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are <u>not</u> new fall and <u>not</u> transient).	30-50% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale).	10-30% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 10% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
SCORE				
2. Pool Substrate Characterization	Mixture of substrate materials, with gravel and firm sand prevalent; root mats and submerged vegetation common.	Mixture of soft sand, mud, or clay; mud may be dominant; some root mats and submerged vegetation present.	All mud or clay or sand bottom; little or no root mat; no submerged vegetation.	Hard-pan clay or bedrock; no root mat or vegetation.
SCORE				
3. Pool Variability	Even mix of large-shallow, large-deep, small-shallow, small-deep pools present.	Majority of pools large-deep; very few shallow.	Shallow pools much more prevalent than deep pools.	Majority of pools small-shallow or pools absent.
SCORE				
4. Sediment Deposition	Little or no enlargement of islands or point bars and less than <20% of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 20-50% of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 50-80% of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 80% of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
SCORE				
5. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or <25% of channel substrate is exposed.	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
SCORE				

Lones Ditch

HABITAT ASSESSMENT FIELD DATA SHEET—LOW GRADIENT STREAMS (BACK)

Parameters to be evaluated broader than sampling reach

Habitat Parameter	Condition Category			
	Optimal	Suboptimal	Marginal	Poor
6. Channel Alteration	Channelization or dredging absent or minimal; stream with normal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.
SCORE				
7. Channel Sinuosity	The bends in the stream increase the stream length 3 to 4 times longer than if it was in a straight line. (Note - channel braiding is considered normal in coastal plains and other low-lying areas. This parameter is not easily rated in these areas.)	The bends in the stream increase the stream length 1 to 2 times longer than if it was in a straight line.	The bends in the stream increase the stream length 1 to 2 times longer than if it was in a straight line.	Channel straight; waterway has been channelized for a long distance.
SCORE				
8. Bank Stability (score each bank)	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
SCORE ___ (LB) SCORE ___ (RB)				
9. Vegetative Protection (score each bank) Note: determine left or right side by facing downstream.	More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.
SCORE ___ (LB) SCORE ___ (RB)				
10. Riparian Vegetative Zone Width (score each bank riparian zone)	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.	Width of riparian zone <6 meters: little or no riparian vegetation due to human activities.
SCORE ___ (LB) SCORE ___ (RB)				

Total Score 59

Lones Ditch

Ohio EPA Qualitative Habitat Evaluation Index Field Sheet QHEI Score: ____

River Code: ______ **RM:** ______ **Stream:** Pike Lake Outflow Channel
Date: 8/20/05 **Location:** ______
Scorers Full Name: EDB/NRT **Affiliation:** ______

1] SUBSTRATE (Check ONLY Two Substrate TYPE BOXES; Estimate % present

TYPE	POOL	RIFFLE	TYPE	POOL	RIFFLE
X BLDR/SLBS[10]	100		GRAVEL [7]		
BOULDER [9]			SAND [6]		
COBBLE [8]			BEDROCK[5]		
HARDPAN [4]			DETRITUS[3]		
MUCK [2]			X ARTIFICIAL[0]	100	
SILT [2]			NOTE: Ignore Sludge Originating From Point Sources		

SUBSTRATE ORIGIN — Check ONE (OR 2 & AVERAGE): LIMESTONE [1]; TILLS [1]; WETLANDS[0]; HARDPAN [0]; SANDSTONE [0]; X RIP/RAP [0]; LACUSTRINE [0]; SHALE [-1]; COAL FINES [-2]

SUBSTRATE QUALITY — Check ONE (OR 2 & AVERAGE):
SILT: X SILT HEAVY [-2]; SILT MODERATE [-1]; SILT NORMAL [0]; SILT FREE [1]
EMBEDDEDNESS: EXTENSIVE [-2]; X MODERATE [-1]; NORMAL [0]; NONE [1]

NUMBER OF SUBSTRATE TYPES: (High Quality Only, Score 5 or >) 4 or More [2]; X 3 or Less [0]

COMMENTS ______

Substrate: 7 (Max 20)

2] INSTREAM COVER (Give each cover type a score of 0 to 3; see back for instructions)
(Structure) TYPE: Score All That Occur

___ UNDERCUT BANKS [1]
___ OVERHANGING VEGETATION [1]
___ SHALLOWS (IN SLOW WATER) [1]
___ ROOTMATS [1]
X POOLS> 70 cm [2]
___ ROOTWADS [1]
___ BOULDERS [1]
___ OXBOWS, BACKWATERS [1]
___ AQUATIC MACROPHYTES [1]
___ LOGS OR WOODY DEBRIS [1]

COMMENTS: ______

AMOUNT: (Check ONLY One or check 2 and AVERAGE): EXTENSIVE > 75% [11]; MODERATE 25-75% [7]; SPARSE 5-25% [3]; X NEARLY ABSENT < 5%[1]

Cover: 3 (Max 20)

3] CHANNEL MORPHOLOGY: (Check ONLY One PER Category OR check 2 and AVERAGE)

SINUOSITY	DEVELOPMENT	CHANNELIZATION	STABILITY
HIGH [4]	EXCELLENT [7]	NONE [6]	X HIGH [3]
MODERATE [3]	GOOD [5]	RECOVERED [4]	MODERATE [2]
LOW [2]	FAIR [3]	RECOVERING [3]	LOW [1]
X NONE [1]	X POOR [1]	X RECENT OR NO RECOVERY [1]	

MODIFICATIONS/OTHER: SNAGGING; RELOCATION; CANOPY REMOVAL; DREDGING; ONE SIDE CHANNEL MODIFICATIONS; IMPOUND.; ISLANDS; LEVEED; BANK SHAPING

COMMENTS: ______

Channel: 6 (Max 20)

4]. RIPARIAN ZONE AND BANK EROSION (check ONE box per bank or check 2 and AVERAGE per bank) River Right Looking Downstream

RIPARIAN WIDTH — L R (Per Bank): WIDE > 50m [4]; MODERATE 10-50m [3]; NARROW 5-10 m [2]; VERY NARROW < 5 m[1]; X X NONE [0]

FLOOD PLAIN QUALITY (PAST 100 Meter RIPARIAN) — L R (Most Predominant Per Bank): FOREST, SWAMP [3]; SHRUB OR OLD FIELD [2]; RESIDENTIAL, PARK, NEW FIELD [1]; FENCED PASTURE [1]; CONSERVATION TILLAGE [1]; X X URBAN OR INDUSTRIAL [0]; OPEN PASTURE, ROWCROP [0]; MINING/CONSTRUCTION [0]

BANK EROSION — L R (Per Bank): X X NONE/LITTLE [3]; MODERATE [2]; HEAVY/SEVERE[1]

COMMENTS: ______

Riparian: 3 (Max 10)

5.]POOL/GLIDE AND RIFFLE/RUN QUALITY

MAX. DEPTH (Check 1 ONLY!): X >1m [6]; 0.7-1m [4]; 0.4-0.7m [2]; 0.2-0.4m [1]; < 0.2m [POOL=0]

MORPHOLOGY (Check 1 or 2 & AVERAGE): POOL WIDTH > RIFFLE WIDTH [2]; POOL WIDTH = RIFFLE WIDTH [1]; POOL WIDTH < RIFFLE W. [0]

CURRENT VELOCITY [POOLS & RIFFLES!] (Check All That Apply): EDDIES[1]; FAST[1]; X MODERATE [1]; SLOW [1]; TORRENTIAL[-1]; INTERSTITIAL[-1]; INTERMITTENT[-2]; VERY FAST[1]

COMMENTS: ______

Pool/Current: 7 (Max 12)

CHECK ONE OR CHECK 2 AND AVERAGE

RIFFLE DEPTH: Best Areas >10 cm [2]; Best Areas 5-10 cm[1]; Best Areas < 5 cm [RIFFLE=0]

RUN DEPTH: MAX > 50 [2]; MAX < 50[1]

RIFFLE/RUN SUBSTRATE: STABLE (e.g.,Cobble, Boulder) [2]; MOD. STABLE (e.g.,Large Gravel) [1]; UNSTABLE (Fine Gravel,Sand) [0]

RIFFLE/RUN EMBEDDEDNESS: NONE [2]; LOW [1]; MODERATE [0]; EXTENSIVE [-1]

COMMENTS: ______ X NO RIFFLE [Metric=0]

Riffle/Run: 0 (Max 8)

6] GRADIENT (ft/mi): ______ DRAINAGE AREA (sq.mi.) : ______

%POOL: 100 %GLIDE: ____
%RIFFLE: ____ %RUN: ____

Gradient: ____ (Max 10)

* Best areas must be large enough to support a population of riffle-obligate species

EPA 4520 06/24/01

PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET (FRONT)

STREAM NAME Pike Lake Outlet	LOCATION Lones Ditch Pike Lake Outlet, Warsaw IN
STATION # ______ RIVERMILE ______	STREAM CLASS
LAT ______ LONG ______	RIVER BASIN
STORET #	AGENCY
INVESTIGATORS EJB, MRT	
FORM COMPLETED BY	DATE 8/20/03 TIME 14:00 AM PM / REASON FOR SURVEY

WEATHER CONDITIONS

Now		Past 24 hours
☐	storm (heavy rain)	☐
☐	rain (steady rain)	☐
☐	showers (intermittent)	☐
___% ☐	%cloud cover	☐ ___%
☒	clear/sunny	☐

Has there been a heavy rain in the last 7 days? ☐ Yes ☒ No

Air Temperature 27 °C

Other ______

SITE LOCATION/MAP

Draw a map of the site and indicate the areas sampled (or attach a photograph)

Upstream and Downstream Facing Photos are attached

STREAM CHARACTERIZATION

Stream Subsystem
☒ Perennial ☐ Intermittent ☐ Tidal

Stream Origin
☐ Glacial
☐ Non-glacial montane
☐ Swamp and bog
☐ Spring-fed
☐ Mixture of origins
☒ Other Lake Outlet

Stream Type
☐ Coldwater ☒ Warmwater

Catchment Area ______ km²

Lones Ditch

PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET (BACK)

WATERSHED FEATURES	**Predominant Surrounding Landuse** ☐ Forest ☒ Commercial ☐ Field/Pasture ☐ Industrial ☐ Agricultural ☐ Other ______ ☒ Residential **Local Watershed NPS Pollution** ☐ No evidence ☐ Some potential sources ☒ Obvious sources **Local Watershed Erosion** ☐ None ☒ Moderate ☐ Heavy
RIPARIAN VEGETATION (18 meter buffer)	**Indicate the dominant type and record the dominant species present** ☐ Trees ☐ Shrubs ☒ Grasses ☒ Herbaceous **dominant species present** Kentucky Bluegrass
INSTREAM FEATURES	**Estimated Reach Length** 100 m **Estimated Stream Width** 11 m **Sampling Reach Area** ____ m² **Area in km² (m²x1000)** ____ km² **Estimated Stream Depth** 1 m **Surface Velocity (at thalweg)** .1 m/sec **Canopy Cover** ☒ Partly open ☐ Partly shaded ☐ Shaded **High Water Mark** 1.2 m **Proportion of Reach Represented by Stream Morphology Types** ☐ Riffle ____% ☐ Run ____% ☒ Pool 100% **Channelized** ☒ Yes ☐ No **Dam Present** ☒ Yes ☐ No
LARGE WOODY DEBRIS	**LWD** 0 m² **Density of LWD** ____ m²/km² (LWD/ reach area)
AQUATIC VEGETATION	**Indicate the dominant type and record the dominant species present** ☐ Rooted emergent ☐ Rooted submergent ☐ Rooted floating ☐ Free floating ☐ Floating Algae ☒ Attached Algae **dominant species present** ______ **Portion of the reach with aquatic vegetation** 5 %
WATER QUALITY	**Temperature** ____ °C 84.27°F **Specific Conductance** Conductivity 509.5 us/cm AC **Dissolved Oxygen** 10043 ug/L **pH** 8.62 **Turbidity** 9.32 **WQ Instrument Used** TROLL 9000 ORP 66 mV **Water Odors** ☐ Normal/None ☐ Sewage ☐ Petroleum ☐ Chemical ☒ Fishy ☐ Other ______ **Water Surface Oils** ☐ Slick ☒ Sheen ☐ Globs ☐ Flecks ☐ None ☐ Other ______ **Turbidity (if not measured)** ☐ Clear ☐ Slightly turbid ☐ Turbid ☐ Opaque ☐ Stained ☐ Other ____
SEDIMENT/ SUBSTRATE	**Odors** ☐ Normal ☒ Sewage ☐ Petroleum ☐ Chemical ☐ Anaerobic ☐ None ☐ Other ______ **Oils** ☒ Absent ☐ Slight ☐ Moderate ☐ Profuse **Deposits** ☐ Sludge ☐ Sawdust ☐ Paper fiber ☐ Sand ☐ Relict shells ☒ Other Moderate Silt **Looking at stones which are not deeply embedded, are the undersides black in color?** ☒ Yes ☐ No

INORGANIC SUBSTRATE COMPONENTS (should add up to 100%)			ORGANIC SUBSTRATE COMPONENTS (does not necessarily add up to 100%)		
Substrate Type	**Diameter**	**% Composition in Sampling Reach**	**Substrate Type**	**Characteristic**	**% Composition in Sampling Area**
Bedrock			Detritus	sticks, wood, coarse plant materials (CPOM)	—
Boulder	> 256 mm (10")				
Cobble	64-256 mm (2.5"-10")	30	Muck-Mud	black, very fine organic (FPOM)	—
Gravel	2-64 mm (0.1"-2.5")	20			
Sand	0.06-2mm (gritty)	30	Marl	grey, shell fragments	2%
Silt	0.004-0.06 mm	20			
Clay	< 0.004 mm (slick)				

Lones Ditch

BENTHIC MACROINVERTEBRATE LABORATORY BENCH SHEET (FRONT)

page ____ of ____

STREAM NAME Pike Lake Outlet	LOCATION Sunset
STATION # ______ RIVERMILE ______	STREAM CLASS
LAT ______ LONG ______	RIVER BASIN
STORET #	AGENCY
COLLECTED BY EJB/NRT DATE 08/20x21/08	LOT #
TAXONOMIST DATE ______	SUBSAMPLE TARGET ☐ 100 ☐ 200 ☐ 300 ☐ Other ____

Enter Family and/or Genus and Species name on blank line.

Organisms		No.	LS	TI	TCR
Oligochaeta					
Hirudinea					
Isopoda					
Amphipoda	ll	2	A	EJB	1
Decapoda	l	1	A	EJB	1
Ephemeroptera					
	Caenis sp.	37			
Caenidae	ИИ ИИ ИИ ИИ ИИ ИИ ИИ ll		I	EJB	1
Heptageniidae Stenacron	llll	4	I	EJB	1
~~Plecoptera~~	Stenacron gildersleevei				
Trichoptera	ИИ ll	7	I	EJB	1
	Polycentropodidae				
	Cyrnellus sp.				
Hemiptera					

Organisms		No.	LS	TI	TCR	
Megaloptera						
Coleoptera Gyrinidae	l	1	A	EJB	1	
larvae Gyrinidae	l	1	I	EJB	1	
Diptera						
Brown	ИИ ИИ ИИ ИИ	ИИ		EJB	lll 1	33
Blood Red	ИИ ИИ ИИ ИИ			EJB	1	31
Gastropoda						
Physa	l	1		EJB		1
Pelecypoda						
Zebra	ИИ ll	7	A	EJB	1	7
Other						
planaria	l	1	A	EJB	1	1
Odonata Zygoptera Coenagrionidae	l	1	I	EJB	1	

Taxonomic certainty rating (TCR) 1-5:1=most certain, 5=least certain. If rating is 3-5, give reason (e.g., missing gills). LS= life stage: I = immature; P = pupa; A = adult TI = Taxonomists initials

Total No. Organisms ____________ **Total No. Taxa** ____________

Center Lake Diagnostic Study - August 20 & 21, 2003 - Lones Ditch or Pike Lake Outlet Channel

Macrobenthos Qualitative Sample List

Vial #	ORDER	FAMILY	GENUS	SPECIES	COUNT	TOLERANCE VALUES	FBI
	Nematomorpha						0.000
	Tubellaria	Planaria			1	4	0.033
	Porifera	Spongillidae					0.000
	Pelecypoda	Corbiculidae	Corbicula	fluminea			0.000
		Dreissenidae	Dreissena	polymorpha	7		0.000
		Sphaeriidae					0.000
	Gastropoda	Ancylidae				6	0.000
		Lymnaeidae	Fossaria			6	0.000
		Physidae	Physella		1	8	0.067
		Planorbidae				7	0.000
		Planorbidae	Planorbula			7	0.000
		Bithyniidae	Bithynia	tentaculata			0.000
	Annelid	Hirudinea				10	0.000
	Oligochaeta						0.000
	Decapoda				1	8	0.067
	Amphipoda				2	4	0.067
	Isopoda	Asellidae				8	0.000
	Ostracoda					8	0.000
1	Ephemeroptera	Caenidae	Caenis		37	7	2.158
		Ephemeridae	Hexagenia			3.6	0.000
		Baetidae	Baetis	brunneicolor		4	0.000
		Baetidae	Baetis	intercalaris		2.7	0.000
		Baetidae	Callibaetis			5.6	0.000
2		Heptageniidae	Stenacron	gildersleevei	4	3.1	0.103
		Heptageniidae	Stenonema	exiguum		4	0.000
		Siphlonuridae				7	0.000
		Ephemerellidae	Timpanoga			1	0.000
		Leptophlebiidae				2	0.000
	Coleoptera	Dytiscidae				5	0.000
		Gyrinidae			2	5	0.083
		Haliplidae				7	0.000
		Dryopidae				5	0.000
		Elmidae				4	0.000
		Psephenidae	Psephenus			4	0.000
		Hydrophiloidae					0.000
	Megaloptera	Sialidae				4	0.000
		Corydalidae	Corydalus			4	0.000
	Trichoptera	Brachycentridae	Brachycentrus			1	0.000
		Helicopsychidae	Helicopsyche	borealis		3	0.000
		Hydropsychidae	Hydropsyche	betteni		4	0.000
		Hydropsychidae	Hydropsyche	scalaris		4	0.000
		Hydroptilidae				4	0.000
		Hydroptilidae	Hydroptila			3.2	0.000
		Leptoceridae	Nectopsyche			4	0.000
		Molannidae				6	0.000
		Philopotamidae				3	0.000
		Phryganeidae	Hagenella			4	0.000
3		Polycentropodidae	Cyrnellus		7	6	0.350
		Psychomyiidae	Lype			2	0.000
	Hemiptera	Belostomatidae					0.000
		Corixidae				10	0.000
		Gerridae				5	0.000
		Nepidae					0.000
	Plecoptera	Perlidae	Perlesta			1	0.000
	Anisoptera	Aeshnidae				3	0.000
		Gomphidae				1	0.000
		Cordulegastridae				3	0.000
		Corduliidae				5	0.000
		Libellulidae				9	0.000
	Zygoptera	Calopterygidae				5	0.000
		Calopterygidae	Calopteryx			3.7	0.000
4		Coenagrionidae			1	6.1	0.051
		Coenagrionidae	Argia			5.1	0.000
		Lestidae				9	0.000
	Diptera	Ceratopogonidae				6	0.000
		Blood-red Chironomidae			31	10	2.583
		Other Chironomidae			33	6	1.650
		Culicidae				8	0.000
		Simuliidae				6	0.000
		Tipulidae				3	0.000
		Stratiomyidae				8	0.000
		Tabanidae				6	0.000

TAXA RICHNESS	12
FBI	7.213
Scraper/Filter	0.357
EPT/Chironomidae	0.750
% Contribution of Domir	0.291
EPT Index	3.000
Community Similarity Indices	
CPOM	
Total Number Collected	127
total shredders	2

HABITAT ASSESSMENT FIELD DATA SHEET—LOW GRADIENT STREAMS (FRONT)

STREAM NAME Walnut Creek	LOCATION Sewage TP
STATION # ________ RIVERMILE ________	STREAM CLASS
LAT ________ LONG ________	RIVER BASIN
STORET #	AGENCY
INVESTIGATORS	
FORM COMPLETED BY	DATE 8/21/05 TIME 12:00 AM PM — REASON FOR SURVEY

Parameters to be evaluated in sampling reach

Habitat Parameter	Condition Category: Optimal	Suboptimal	Marginal	Poor
1. Epifaunal Substrate/ Available Cover	Greater than 50% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient).	30-50% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale).	10-30% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 10% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
SCORE				
2. Pool Substrate Characterization	Mixture of substrate materials, with gravel and firm sand prevalent; root mats and submerged vegetation common.	Mixture of soft sand, mud, or clay; mud may be dominant; some root mats and submerged vegetation present.	All mud or clay or sand bottom; little or no root mat; no submerged vegetation.	Hard-pan clay or bedrock; no root mat or vegetation.
SCORE				
3. Pool Variability	Even mix of large-shallow, large-deep, small-shallow, small-deep pools present.	Majority of pools large-deep; very few shallow.	Shallow pools much more prevalent than deep pools.	Majority of pools small-shallow or pools absent.
SCORE				
4. Sediment Deposition	Little or no enlargement of islands or point bars and less than <20% of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 20-50% of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 50-80% of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 80% of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
SCORE				
5. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or <25% of channel substrate is exposed.	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
SCORE				

11

Walnut Creek

HABITAT ASSESSMENT FIELD DATA SHEET—LOW GRADIENT STREAMS (BACK)

Parameters to be evaluated broader than sampling reach

Habitat Parameter	Condition Category			
	Optimal	Suboptimal	Marginal	Poor
6. Channel Alteration	Channelization or dredging absent or minimal; stream with normal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.
SCORE				
7. Channel Sinuosity	The bends in the stream increase the stream length 3 to 4 times longer than if it was in a straight line. (Note - channel braiding is considered normal in coastal plains and other low-lying areas. This parameter is not easily rated in these areas.)	The bends in the stream increase the stream length 1 to 2 times longer than if it was in a straight line.	The bends in the stream increase the stream length 1 to 2 times longer than if it was in a straight line.	Channel straight; waterway has been channelized for a long distance.
SCORE				
8. Bank Stability (score each bank)	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
SCORE ___ (LB)				
SCORE ___ (RB)				
9. Vegetative Protection (score each bank) Note: determine left or right side by facing downstream.	More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.
SCORE ___ (LB)				
SCORE ___ (RB)				
10. Riparian Vegetative Zone Width (score each bank riparian zone)	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.	Width of riparian zone <6 meters: little or no riparian vegetation due to human activities.
SCORE ___ (LB)				
SCORE ___ (RB)				

Total Score __________

OhioEPA Qualitative Habitat Evaluation Index Field Sheet QHEI Score: ___

River Code: ______ **RM:** ______ **Stream:** Walnut Creek
Date: 8/21/03 **Location:** Sewage Treatment Plant
Scorers Full Name: ______ **Affiliation:** ______

1] SUBSTRATE (Check ONLY Two Substrate TYPE BOXES; Estimate % present

TYPE	POOL	RIFFLE		POOL	RIFFLE
BLDR /SLBS[10]			GRAVEL [7]		
BOULDER [9]			X SAND [6]	100	
COBBLE [8]			BEDROCK[5]		
HARDPAN [4]			DETRITUS[3]		
MUCK [2]			ARTIFICIAL[0]		
X SILT [2]	100		NOTE: Ignore Sludge Originating From Point Sources		

SUBSTRATE ORIGIN — Check ONE (OR 2 & AVERAGE)
- LIMESTONE [1]
- X TILLS [1]
- WETLANDS[0]
- HARDPAN [0]
- SANDSTONE [0]
- RIP/RAP [0]
- LACUSTRINE [0]
- SHALE [-1]
- COAL FINES [-2]

SUBSTRATE QUALITY — Check ONE (OR 2 & AVERAGE)
- SILT: SILT HEAVY [-2]; X SILT MODERATE [-1]; SILT NORMAL [0]; SILT FREE [1]
- EMBEDDEDNESS: EXTENSIVE [-2]; X MODERATE [-1]; NORMAL [0]; NONE [1]

NUMBER OF SUBSTRATE TYPES: (High Quality Only, Score 5 or >) X 4 or More [2]; 3 or Less [0]

COMMENTS ______

Substrate: 9 (Max 20)

2] INSTREAM COVER (Give each cover type a score of 0 to 3; see back for instructions) (Structure) TYPE: Score All That Occur

- ___ UNDERCUT BANKS [1]
- X OVERHANGING VEGETATION [1]
- ___ SHALLOWS (IN SLOW WATER) [1]
- ___ ROOTMATS [1]
- ___ POOLS > 70 cm [2]
- ___ ROOTWADS [1]
- ___ BOULDERS [1]
- ___ OXBOWS, BACKWATERS [1]
- X AQUATIC MACROPHYTES [1]
- ___ LOGS OR WOODY DEBRIS [1]

COMMENTS: ______

AMOUNT: (Check ONLY One or check 2 and AVERAGE)
- EXTENSIVE > 75% [11]
- MODERATE 25-75% [7]
- X SPARSE 5-25% [3]
- NEARLY ABSENT < 5%[1]

Cover: 5 (Max 20)

3] CHANNEL MORPHOLOGY: (Check ONLY One PER Category OR check 2 and AVERAGE)

SINUOSITY	DEVELOPMENT	CHANNELIZATION	STABILITY
HIGH [4]	EXCELLENT [7]	NONE [6]	HIGH [3]
MODERATE [3]	GOOD [5]	RECOVERED [4]	MODERATE [2]
X LOW [2]	FAIR [3]	X RECOVERING [3]	X LOW [1]
NONE [1]	X POOR [1]	RECENT OR NO RECOVERY [1]	

MODIFICATIONS/OTHER
- SNAGGING
- RELOCATION
- CANOPY REMOVAL
- DREDGING
- ONE SIDE CHANNEL MODIFICATIONS
- IMPOUND.
- ISLANDS
- LEVEED
- BANK SHAPING

COMMENTS: ______

Channel: 7 (Max 20)

4]. RIPARIAN ZONE AND BANK EROSION (check ONE box per bank or check 2 and AVERAGE per bank) River Right Looking Downstream

RIPARIAN WIDTH — L R (Per Bank)
- WIDE > 50m [4]
- MODERATE 10-50m [3]
- NARROW 5-10m [2]
- X X VERY NARROW < 5 m [1]
- NONE [0]

FLOOD PLAIN QUALITY (PAST 100 Meter RIPARIAN) — L R (Most Predominant Per Bank)
- FOREST, SWAMP [3]
- SHRUB OR OLD FIELD [2]
- RESIDENTIAL, PARK, NEW FIELD [1]
- FENCED PASTURE [1]
- CONSERVATION TILLAGE [1]
- X X URBAN OR INDUSTRIAL [0]
- OPEN PASTURE, ROWCROP [0]
- MINING/CONSTRUCTION [0]

BANK EROSION — L R (Per Bank)
- NONE/LITTLE [3]
- X X MODERATE [2]
- HEAVY/SEVERE[1]

COMMENTS: ______

Riparian: 3 (Max 10)

5.]POOL/GLIDE AND RIFFLE/RUN QUALITY

MAX. DEPTH (Check 1 ONLY!)
- \>1m [6]
- 0.7-1m [4]
- 0.4-0.7m [2]
- X 0.2-0.4m [1]
- < 0.2m [POOL=0]

MORPHOLOGY (Check 1 or 2 & AVERAGE)
- POOL WIDTH > RIFFLE WIDTH [2]
- X POOL WIDTH = RIFFLE WIDTH [1]
- POOL WIDTH < RIFFLE W. [0]

CURRENT VELOCITY [POOLS & RIFFLES!] (Check All That Apply)
- EDDIES[1]
- FAST[1]
- X MODERATE [1]
- SLOW [1]
- TORRENTIAL[-1]
- INTERSTITIAL[-1]
- INTERMITTENT[-2]
- VERY FAST[1]

COMMENTS: ______

Pool/Current: 3 (Max 12)

CHECK ONE OR CHECK 2 AND AVERAGE

RIFFLE DEPTH
- Best Areas >10 cm [2]
- X Best Areas 5-10 cm[1]
- Best Areas < 5 cm [RIFFLE=0]

RUN DEPTH
- MAX > 50 [2]
- X MAX < 50[1]

RIFFLE/RUN SUBSTRATE
- STABLE (e.g.,Cobble, Boulder) [2]
- MOD. STABLE (e.g.,Large Gravel) [1]
- X UNSTABLE (Fine Gravel,Sand) [0]

RIFFLE/RUN EMBEDDEDNESS
- NONE [2]
- LOW [1]
- X MODERATE [0]
- EXTENSIVE [-1]

COMMENTS: ______ NO RIFFLE [Metric=0]

Riffle/Run: 2 (Max 8)

6] GRADIENT (ft/mi): ______ DRAINAGE AREA (sq.mi.) : ______

%POOL: ___ %GLIDE: ___
%RIFFLE: ___ %RUN: 100

Gradient: ___ (Max 10)

* Best areas must be large enough to support a population of riffle-obligate species

EPA 4520 06/24/01

PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET (FRONT)

STREAM NAME Walnut Creek	LOCATION Wastewater Treatment Plant
STATION # ________ RIVERMILE ________	STREAM CLASS
LAT ________ LONG ________	RIVER BASIN
STORET #	AGENCY
INVESTIGATORS	
FORM COMPLETED BY	DATE ________ TIME ________ AM PM / REASON FOR SURVEY

WEATHER CONDITIONS

Now		Past 24 hours
☐	storm (heavy rain)	☐
☐	rain (steady rain)	☐
☐	showers (intermittent)	☐
___%☐	%cloud cover	☐ ___%
☒	clear/sunny	☐

Has there been a heavy rain in the last 7 days?
☐ Yes ☒ No

Air Temperature 29 °C

Other ________

SITE LOCATION/MAP

Draw a map of the site and indicate the areas sampled (or attach a photograph)

Upstream and Downstream Facing
Photos are attached

STREAM CHARACTERIZATION

Stream Subsystem
☒ Perennial ☐ Intermittent ☐ Tidal

Stream Type
☐ Coldwater ☒ Warmwater

Stream Origin
☐ Glacial
☐ Non-glacial montane
☐ Swamp and bog
☐ Spring-fed
☒ Mixture of origins
☐ Other________

Catchment Area________km²

Walnut Creek

PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET (BACK)

WATERSHED FEATURES

Predominant Surrounding Landuse
☐ Forest ☐ Commercial
☐ Field/Pasture ☐ Industrial
☐ Agricultural ☒ Other Wastewater Treatment Plant
☐ Residential

Local Watershed NPS Pollution
☐ No evidence ☒ Some potential sources
☐ Obvious sources

Local Watershed Erosion
☐ None ☒ Moderate ☐ Heavy

RIPARIAN VEGETATION (18 meter buffer)

Indicate the dominant type and record the dominant species present
☐ Trees ☐ Shrubs ☒ Grasses ☒ Herbaceous

dominant species present Kentucky Bluegrass

INSTREAM FEATURES

Estimated Reach Length 100 m
Estimated Stream Width 18 m
Sampling Reach Area ____ m²
Area in km² (m²x1000) ____ km²
Estimated Stream Depth .3 m
Surface Velocity (at thalweg) .2 m/sec

Canopy Cover
☐ Partly open ☐ Partly shaded ☐ Shaded

High Water Mark 1.2 m

Proportion of Reach Represented by Stream Morphology Types
☒ Riffle 15 % ☒ Run 75 %
☒ Pool 10 %

Channelized ☒ Yes ☐ No
Dam Present ☒ Yes ☐ No elevation control structure

LARGE WOODY DEBRIS

LWD 2 m²
Density of LWD ____ m²/km² (LWD/ reach area)

AQUATIC VEGETATION

Indicate the dominant type and record the dominant species present
☐ Rooted emergent ☒ Rooted submergent ☐ Rooted floating ☐ Free floating
☐ Floating Algae ☒ Attached Algae

dominant species present ____

Portion of the reach with aquatic vegetation 10 %

WATER QUALITY

Temperature ____ °C 16.04°F
Specific Conductance ____ 1312 conductance
Dissolved Oxygen 7630
pH 7.92
Turbidity 468
WQ Instrument Used TROLL 9000
ORP 114

Water Odors
☐ Normal/None ☐ Sewage
☐ Petroleum ☐ Chemical
☐ Fishy ☐ Other____

Water Surface Oils
☐ Slick ☐ Sheen ☐ Globs ☐ Flecks
☐ None ☐ Other____

Turbidity (if not measured)
☐ Clear ☐ Slightly turbid ☐ Turbid
☐ Opaque ☐ Stained ☐ Other____

SEDIMENT/ SUBSTRATE

Odors
☐ Normal ☒ Sewage ☐ Petroleum
☐ Chemical ☐ Anaerobic ☐ None
☐ Other____

Oils
☒ Absent ☐ Slight ☐ Moderate ☐ Profuse

Deposits
☐ Sludge ☐ Sawdust ☐ Paper fiber ☒ Sand
☐ Relict shells ☐ Other____

Looking at stones which are not deeply embedded, are the undersides black in color?
☒ Yes ☐ No

INORGANIC SUBSTRATE COMPONENTS (should add up to 100%)			ORGANIC SUBSTRATE COMPONENTS (does not necessarily add up to 100%)		
Substrate Type	Diameter	% Composition in Sampling Reach	Substrate Type	Characteristic	% Composition in Sampling Area
Bedrock			Detritus	sticks, wood, coarse plant materials (CPOM)	10%
Boulder	> 256 mm (10")				
Cobble	64-256 mm (2.5"-10")	5 %	Muck-Mud	black, very fine organic (FPOM)	10%
Gravel	2-64 mm (0.1"-2.5")	15 %			
Sand	0.06-2mm (gritty)	60 %	Marl	grey, shell fragments	2%
Silt	0.004-0.06 mm	20 %			
Clay	< 0.004 mm (slick)				

BENTHIC MACROINVERTEBRATE LABORATORY BENCH SHEET (FRONT)

page ____ of ____

STREAM NAME Walnut Creek	LOCATION Sewage Treatment Plant
STATION # ______ RIVERMILE ______	STREAM CLASS
LAT ______ LONG ______	RIVER BASIN
STORET #	AGENCY
COLLECTED BY EJB/MRT DATE 8/21/03	LOT #
TAXONOMIST DATE ______	SUBSAMPLE TARGET ☐ 100 ☐ 200 ☐ 300 ☐ Other ____

Enter Family and/or Genus and Species name on blank line.

Organisms		No.	LS	TI	TCR
Oligochaeta	|||| (4)	4	A	EJB	1
Hirudinea					
Isopoda					
Amphipoda	~~HH HH~~ (10)	10	A	EJB	1
Decapoda					
Ephemeroptera					
Baetidae -	|||| Baetidae Callibaetis	4	I	EJB	1
Caenidae -	HH HH Caenidae Caenis	10	I	EJB	1
* ~~Heptag~~ -	|||| Stenonema? (4)	4	I	EJB	1
Plecoptera					
Trichoptera					
Micro caddis Portable	Hydroptilidae Hydroptila Hydroptilidae				
SAND	|||	3	I	EJB	1
Hemiptera	[redacted]				
[redacted]	[redacted]				

Organisms		No.	LS	TI	TCR	
Megaloptera						
Coleoptera						
PREDAT	|||| Dytiscidae	4	A	EJB	1	(4)
Diptera						
[redacted]	[redacted]					
CULI	|| Culicidae	2	I	EJB	1	(2)
Red -	HH HH HH HH HH	45	I	EJB	1	(45)
Brown -	HH HH HH HH	27	I	EJB	1	(27)
Gastropoda						
PLANORB	HH (5)	5	A	EJB	1	(5)
PHYSA	HH HH III (13)	13	A	EJB	1	(13)
Pelecypoda						
Asian? CLAM	|| (2)	2	A	EJB	1	(2)
Other						
ANISOP	HH					
ZYGOPT	~~HH HH HH HH ||~~					
PLANARIA	|||| (4) (4)	4	A	EJB	1	(4)
Zygoptera	Calopterygidae Calopteryx	3	I	EJB	1	(3)
Zygoptera	Coenagrionidae Argia	5	I	EJB	1	(5)
Zygoptera	Coenagrionidae	14	I	EJB	1	(14)
Anisoptera	Gomphidae	1	I	EJB	1	
Anisoptera	Corduliidae	2	I	EJB	1	
Anisoptera	Aeshnidae	2	I	EJB	1	

Taxonomic certainty rating (TCR) 1-5:1=most certain, 5=least certain. If rating is 3-5, give reason (e.g., missing gills). LS= life stage: I = immature; P = pupa; A = adult TI = Taxonomists initials

Total No. Organisms ____________ Total No. Taxa ____________

Center Lake Diagnostic Study - August 21, 2003 - Walnut Creek, below WWTP & above outlet from Center Lake Dam

Macrobenthos Qualitative Sample List

Vial #	ORDER	FAMILY	GENUS	SPECIES	COUNT	TOLERANCE VALUES	FBI
	Nematomorpha						0.000
	Tubellaria	Planaria			4	4	0.101
	Porifera	Spongillidae					0.000
	Pelecypoda	Corbiculidae	Corbicula	fluminea	2		0.000
		Dreissenidae	Dreissena	polymorpha			0.000
		Sphaeriidae					0.000
	Gastropoda	Ancylidae				6	0.000
		Lymnaeidae	Fossaria			6	0.000
		Physidae	Physella		13	8	0.658
		Planorbidae			5	7	0.222
		Planorbidae	Planorbula			7	0.000
		Bithyniidae	Bithynia	tentaculata			0.000
	Annelid	Hirudinea				10	0.000
	Oligochaeta				4		0.000
	Decapoda					8	0.000
	Amphipoda				10	4	0.253
	Isopoda	Asellidae				8	0.000
	Ostracoda					8	0.000
	Ephemeroptera	Caenidae	Caenis		10	7	0.443
		Ephemeridae	Hexagenia			3.6	0.000
		Baetidae	Baetis	brunneicolor		4	0.000
		Baetidae	Baetis	intercalaris		2.7	0.000
5		Baetidae	Callibaetis		4	5.6	0.142
		Heptageniidae	Stenacron	gildersleevei	4	3.1	0.078
		Heptageniidae	Stenonema	exiguum		4	0.000
		Siphlonuridae				7	0.000
		Ephemerellidae	Timpanoga			1	0.000
		Leptophlebiidae				2	0.000
	Coleoptera	Dytiscidae			4	5	0.127
		Gyrinidae				5	0.000
		Haliplidae				7	0.000
		Dryopidae				5	0.000
		Elmidae				4	0.000
		Psephenidae	Psephenus			4	0.000
		Hydrophiloidae					0.000
	Megaloptera	Sialidae				4	0.000
		Corydalidae	Corydalus			4	0.000
	Trichoptera	Brachycentridae	Brachycentrus			1	0.000
		Helicopsychidae	Helicopsyche	borealis		3	0.000
		Hydropsychidae	Hydropsyche	betteni		4	0.000
		Hydropsychidae	Hydropsyche	scalaris		4	0.000
		Hydroptilidae				4	0.000
6		Hydroptilidae	Hydroptila		3	3.2	0.061
		Leptoceridae	Nectopsyche			4	0.000
		Molannidae				6	0.000
		Philopotamidae				3	0.000
		Phryganeidae	Hagenella			4	0.000
		Polycentropodidae	Cymellus			6	0.000
		Psychomyiidae	Lype			2	0.000
	Hemiptera	Belostomatidae					0.000
		Corixidae				10	0.000
		Gerridae				5	0.000
		Nepidae					0.000
	Plecoptera	Perlidae	Perlesta			1	0.000
	Anisoptera	Aeshnidae			2	3	0.038
		Gomphidae			1	1	0.006
		Cordulegastridae				3	0.000
		Corduliidae			2	5	0.063
		Libellulidae				9	0.000
	Zygoptera	Calopterygidae				5	0.000
7		Calopterygidae	Calopteryx		3	3.7	0.070
		Coenagrionidae			14	6.1	0.541
8		Coenagrionidae	Argia		5	5.1	0.161
		Lestidae				9	0.000
	Diptera	Ceratopogonidae				6	0.000
		Blood-red Chironomidae			46	10	2.848
		Other Chironomidae			27	6	1.025
		Culicidae			2	8	0.101
		Simuliidae				6	0.000
		Tipulidae				3	0.000
		Stratiomyidae				8	0.000
		Tabanidae				6	0.000

TAXA RICHNESS	20
FBI	6.939
Scraper/Filter	11.000
EPT/Chironomidae	0.292
% Contribution of Domi	0.274
EPT Index	4.000
Community Similarity Indices	
CPOM	
Total Number Collected	164
total shredders	12

PHOTO 1

08/21/03

Walnut Creek water quality and macroinvertebrate sampling location. Facing upstream.

PHOTO 2

08/21/03

Walnut Creek water quality and macroinvertebrate sampling location. Facing downstream.

PHOTO 3

08/20/03

Long Creek water quality and macroinvertebrate sampling location. Facing upstream.

PHOTO 4

08/20/03

Long Creek water quality and macroinvertebrate sampling location. Facing downstream.

PHOTO 5

08/21/03

Tippecanoe River water quality and macroinvertebrate sampling location. Facing upstream.

PHOTO 6

08/21/03

Tippecanoe River water quality and macroinvertebrate sampling location. Facing downstream.

APPENDIX VII:

AQUATIC VEGETATIVE TRANSECT SAMPLING DATA SHEETS

Aquatic Vegetation Transect Sampling

Waterbody Cover Sheet

Surveying Organization: V3 Consultants

Waterbody Name: Center Lake

Lake ID:

County: Kosciusko

Date: July 17,18-2003

Habitat Stratum: IL

Ave. Lake Depth (ft): 21 feet

Lake Level: Normal

Crew Leader: Ed Belmonte

GPS Metadata

Datum:

Zone:

Accuracy:

Recorder: George Milner

Method: Aquatic Vegetation Transect Sampling (Shuler + Hoffman 2002)

Secchi Depth (ft):

Total # of Transects Surveyed: 6

Total # of Species: 17

Littoral Zone Size (acres): 50 Acres

- [x] Measured
- [ ] Estimated

Littoral Zone Max. Depth (ft): 9.1

- [x] Measured
- [ ] Estimate (historical Secchi)
- [ ] Estimated (current Secchi)

Notable Conditions:

Lake is 120-Acres
1,680 - Acre feet Volume
42 feet maximum Depth

Transect Summary Data

Transect ID: T1

Dom. Substrate: 2 | # of Sites (usually 5): 5 | Total # of Species: 7

Transect Start Coordinates
Latitude (DD): 41D;14.716N
Longitude (DD): 85D;51.722W

Transect End Coordinates
Latitude (DD): 41D;14.771N
Longitude (DD): 85D;51.648W

Notable Landmark(s):
375' Long Transect
- South of outlet Dam

Transect Summary Data

Transect ID: T2

Dom. Substrate: 2 | # of Sites (usually 5): 5 | Total # of Species: 8

Transect Start Coordinates
Latitude (DD): 41D;14.942N
Longitude (DD): 85D;51.348W

Transect End Coordinates
Latitude (DD): 41D;15.079N
Longitude (DD): 85D;51.306W

Notable Landmark(s):

Transect Summary Data

Transect ID: T3

Dom. Substrate: 2 | # of Sites (usually 5): 5 | Total # of Species: 5

Transect Start Coordinates
Latitude (DD): 41D;14.819N
Longitude (DD): 85D;51.223W

Transect End Coordinates
Latitude (DD): 41D;14.812N
Longitude (DD): 85D;51.244N

Notable Landmark(s):

Aquatic Vegetation Transect Site Data Sheet

State of Indiana Department of Natural Resources

ORGANIZATION: V3 Consultants

DATE: 7/17/03

SITE INFORMATION

Transect ID: T1
Site ID: 01
Substrate: 2
Marl? 1
High Organic? 1

Waterbody Name: Center Lake
Waterbody ID:
Total # of Species 6

Canopy Abundance at Site

S: 1 | N: 1 | F: 4 | E: 0

SITE COORDINATES

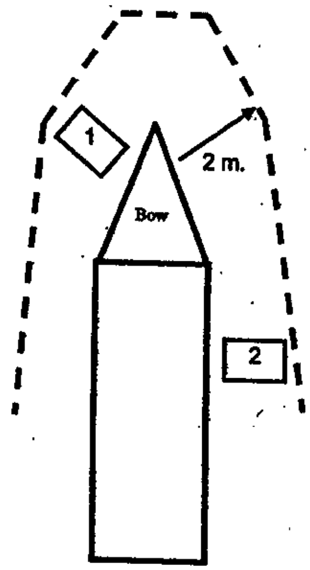
Latitude: 41D 14.716N
Longitude: 85D 51.722W

SUBSAMPLE SITE INFORMATION

	1	2
Water Depth @ Subsample Site:	3.8'	3.3'
Plant Density w/ Rake @ Subsample Site:	2	3

SPECIES INFORMATION

Species Code	V	R 1	R 2	QE	Voucher
NUPADV	4	1	1	0	0
LEMMIN	1	=	=	0	0
MYRSPI	1	1	1	0	0
POTPEC	1	1	1	0	0
CERDEM	1	1	2	0	0
CHAVUL	A	1	2	0	0



Each subsampling area is 1.5 m long X 0.36 m wide.

Comments:

1 meter from T1 start point

REMINDER INFORMATION

Substrate:
1 = Silt/Clay
2 = Silt w/Sand
3 = Sand w/Silt
4 = Hard Clay
5 = Gravel/Rock
6 = Sand

Marl
1 = Present
0 = absent

High Organic
1 = Present
0 = absent

Overall Surface Cover
N = Nonrooted floating
F = Floating, rooted
E = Emergent
S = Submersed

Canopy:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

Plant Density
0 = None
1 = 1-20%
2 = 21-40%
3 = 41-60%
4 = 61-80%
5 = 81-100%

V:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

R:
Blank=none
1 = 1-20%
2 = 21-40%
3 = 41-60%
4 = 61-80%
5 = 81-100%

QE Code:
0 = as defined
1 = Species suspecte
2 = Genus suspected
3 = Unknown

Voucher
0 = Not Taken
1 = Taken, not varified
2 = Taken, varified

Aquatic Vegetation Transect Site Data Sheet

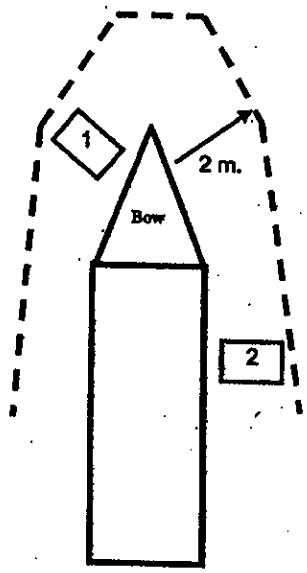
State of Indiana Department of Natural Resources

ORGANIZATION: V3 Consultants	DATE: 7/17/03

SITE INFORMATION		SITE COORDINATES		
Transect ID: T1	Waterbody Name: Center Lake	Latitude: 41D 14.751 N		
Site ID: 02		Longitude: 85D 51.697 W		
Substrate: 2	Waterbody ID:	SUBSAMPLE SITE INFORMATION		
Marl? 1	Total # of Species 5		1	2
High Organic? 1	CanopyAbundance at Site: S: 2 N: 1 F: 4 E: 0	Water Depth @ Subsample Site:	4.2'	4.3'
		Plant Density w/ Rake @ Subsample Site:	3	1

SPECIES INFORMATION

Species Code	V	R 1	R 2	QE	Voucher
NUPADV	4	1	1	0	0
MYRSPI	1	1	–	0	0
LEMMIN	1	1	–	0	0
CERDEM	1	2	1	0	0
POTPEC	1	–	1	0	0
WOLCOL	1	–	–	0	0



Each subsampling area is 1.5 m long X 0.36 m wide.

Comments:

92' east of 01
– edge of lily est.
(openwater/lily interface)

REMINDER INFORMATION

Substrate:
1 = Silt/Clay
2 = Silt w/Sand
3 = Sand w/Silt
4 = Hard Clay
5 = Gravel/Rock
6 = Sand

Marl
1 = Present
0 = absent

High Organic
1 = Present
0 = absent

Overall Surface Cover
N = Nonrooted floating
F = Floating, rooted
E = Emergent
S = Submersed

Canopy:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

Plant Density
0 = None
1 = 1-20%
2 = 21-40%
3 = 41-60%
4 = 61-80%
5 = 81-100%

V:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

R:
Blank=none
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4 = 61-80%
5 = 81-100%

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Voucher
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2 = Taken, varified

Aquatic Vegetation Transect Site Data Sheet

State of Indiana Department of Natural Resources

ORGANIZATION: V3 Consultants | DATE: 7/17/03

SITE INFORMATION		SITE COORDINATES	
Transect ID: T1	Waterbody Name: Center Lake	Latitude:	41D 14.760N
Site ID: 03		Longitude:	85D 51.677W
Substrate: 2	Waterbody ID:		
Marl? 1	Total # of Species 5		
High Organic? 1			

SUBSAMPLE SITE INFORMATION

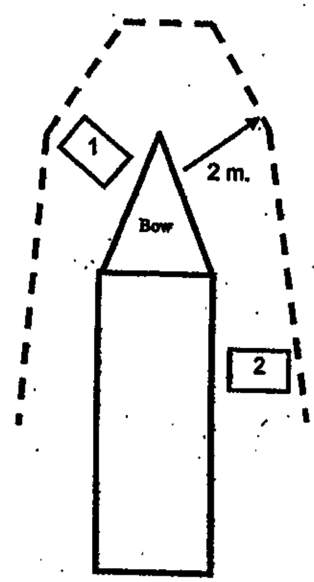
	1	2
Water Depth @ Subsample Site:	5.4'	5.3'
Plant Density w/ Rake @ Subsample Site:	1	2

Canopy Abundance at Site

S:	N:	F:	E:
1	1	0	0

SPECIES INFORMATION

Species Code	V	R 1	R 2	QE	Voucher
MYRSPI	1	1	1	0	0
LEMMIN	1	–	1	0	0
CERDEM	1	1	1	0	0
POTDEC	1	1	–	0	0
CHAVUL	1	–	1	0	0



Each subsampling area is 1.5 m long X 0.36 m wide.

Comments:

REMINDER INFORMATION

Substrate:
1 = Silt/Clay
2 = Silt w/Sand
3 = Sand w/Silt
4 = Hard Clay
5 = Gravel/Rock
6 = Sand

Marl
1 = Present
0 = absent

High Organic
1 = Present
0 = absent

Overall Surface Cover
N = Nonrooted floating
F = Floating, rooted
E = Emergent
S = Submersed

Canopy:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

Plant Density
0 = None
1 = 1-20%
2 = 21-40%
3 = 41-60%
4 = 61-80%
5 = 81-100%

V:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

R:
Blank=none
1 = 1-20%
2 = 21-40%
3 = 41-60%
4 = 61-80%
5 = 81-100%

QE Code:
0 = as defined
1 = Species suspecte
2 = Genus suspected
3 = Unknown

Voucher
0 = Not Taken
1 = Taken, not varified
2 = Taken, varified

Aquatic Vegetation Transect Site Data Sheet

State of Indiana Department of Natural Resources

ORGANIZATION: V3 Consultants

DATE: 7/17/03

SITE INFORMATION

Transect ID: T1
Site ID: 04
Substrate: 2
Marl? 1
High Organic? 1

Waterbody Name: Center Lake
Waterbody ID:
Total # of Species 2

Canopy Abundance at Site

S: 1 | N: 0 | F: 0 | E: 0

SITE COORDINATES

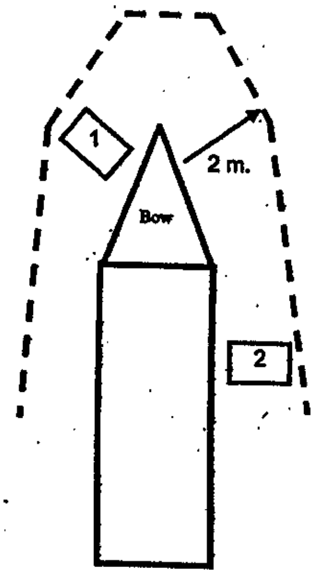
Latitude: 41D 14.772N
Longitude: 85D 51.652W

SUBSAMPLE SITE INFORMATION

	1	2
Water Depth @ Subsample Site:	6.8'	6.8'
Plant Density w/ Rake @ Subsample Site:	2	1

SPECIES INFORMATION

Species Code	V	R 1	R 2	QE	Voucher
MYRSPI	1	1	1	0	0
CERDEM	1	2	1	0	0



Each subsampling area is 1.5 m long X 0.36 m wide.

Comments:

REMINDER INFORMATION

Substrate:
1 = Silt/Clay
2 = Silt w/Sand
3 = Sand w/Silt
4 = Hard Clay
5 = Gravel/Rock
6 = Sand

Marl
1 = Present
0 = absent

High Organic
1 = Present
0 = absent

Overall Surface Cover
N = Nonrooted floating
F = Floating, rooted
E = Emergent
S = Submersed

Canopy:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

Plant Density
0 = None
1 = 1-20%
2 = 21-40%
3 = 41-60%
4 = 61-80%
5 = 81-100%

V:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

R:
Blank=none
1 = 1-20%
2 = 21-40%
3 = 41-60%
4 = 61-80%
5 = 81-100%

QE Code:
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1 = Species suspecte
2 = Genus suspected
3 = Unknown

Voucher
0 = Not Taken
1 = Taken, not varified
2 = Taken, varified

Aquatic Vegetation Transect Site Data Sheet

State of Indiana Department of Natural Resources

ORGANIZATION:	V3 Consultants	DATE:	7/17/03

SITE INFORMATION

Transect ID:	T1	Waterbody Name: Center Lake	
Site ID:	05		
Substrate:	1	Waterbody ID:	
Marl?	1	Total # of Species	3
High Organic?	0		

Canopy Abundance at Site

S:	N:	F:	E:
1	1	0	0

SITE COORDINATES

Latitude: 41D 14.771N

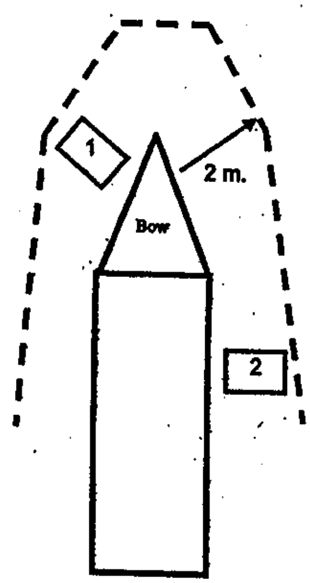
Longitude: 85D 51.648W

SUBSAMPLE SITE INFORMATION

	1	2
Water Depth @ Subsample Site:	9.11	8.61
Plant Density w/ Rake @ Subsample Site:	1	1

SPECIES INFORMATION

Species Code	V	R 1	R 2	QE	Voucher
MYRSPI	1	–	1	0	0
LEMMIN	1	–	–	0	0
CERDEM	+	1	1	0	0



Each subsampling area is 1.5 m long X 0.36 m wide.

Comments:

REMINDER INFORMATION

Substrate:
1 = Silt/Clay
2 = Silt w/Sand
3 = Sand w/Silt
4 = Hard Clay
5 = Gravel/Rock
6 = Sand

Marl
1 = Present
0 = absent

High Organic
1 = Present
0 = absent

Overall Surface Cover
N = Nonrooted floating
F = Floating, rooted
E = Emergent
S = Submersed

Canopy:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

Plant Density
0 = None
1 = 1-20%
2 = 21-40%
3 = 41-60%
4 = 61-80%
5 = 81-100%

V:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

R:
Blank=none
1 = 1-20%
2 = 21-40%
3 = 41-60%
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QE Code:
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1 = Species suspecte
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Voucher
0 = Not Taken
1 = Taken, not varified
2 = Taken, varified

Aquatic Vegetation Transect Site Data Sheet

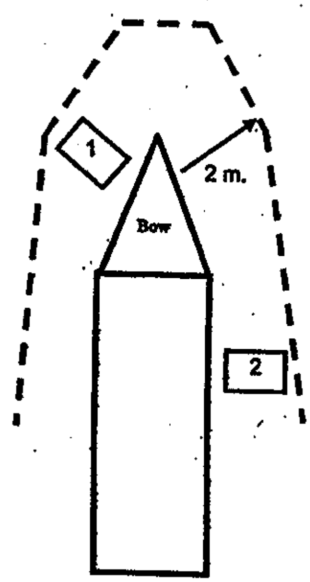
State of Indiana Department of Natural Resources

ORGANIZATION: V3 Consultants	DATE: 7/17/03

SITE INFORMATION		SITE COORDINATES		
Transect ID: T2	Waterbody Name: Center Lake	Latitude: 41D 14.942N		
Site ID: 01		Longitude: 85D 51.348W		
Substrate: 2	Waterbody ID:	SUBSAMPLE SITE INFORMATION		
Marl? 1	Total # of Species 2		1	2
High Organic? 1	Canopy Abundance at Site: S: 1, N: 0, F: 0, E: 0	Water Depth @ Subsample Site:	7.3'	7.3'
		Plant Density w/ Rake @ Subsample Site:	2	3

SPECIES INFORMATION

Species Code	V	R 1	R 2	QE	Voucher
MYRSPI	1	1	1	0	0
CERDEM	1	1	2	0	0



Each subsampling area is 1.5 m long X 0.36 m wide.

Comments:

REMINDER INFORMATION

Substrate:
1 = Silt/Clay
2 = Silt w/Sand
3 = Sand w/Silt
4 = Hard Clay
5 = Gravel/Rock
6 = Sand

Marl
1 = Present
0 = absent

High Organic
1 = Present
0 = absent

Overall Surface Cover
N = Nonrooted floating
F = Floating, rooted
E = Emergent
S = Submersed

Canopy:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

Plant Density
0 = None
1 = 1-20%
2 = 21-40%
3 = 41-60%
4 = 61-80%
5 = 81-100%

V:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

R:
Blank=none
1 = 1-20%
2 = 21-40%
3 = 41-60%
4 = 61-80%
5 = 81-100%

QE Code:
0 = as defined
1 = Species suspecte
2 = Genus suspected
3 = Unknown

Voucher
0 = Not Taken
1 = Taken, not varified
2 = Taken, varified

Aquatic Vegetation Transect Site Data Sheet

State of Indiana Department of Natural Resources

ORGANIZATION: V3 Consultants

DATE: 7/17/03

SITE INFORMATION

Transect ID: T2

Site ID: 02

Substrate: 2

Marl? 1

High Organic? 1

Waterbody Name: Center Lake

Waterbody ID:

Total # of Species: 3

CanopyAbundance at Site

S: 2	N: 0	F: 0	E: 0

SITE COORDINATES

Latitude: 41D 14.975N

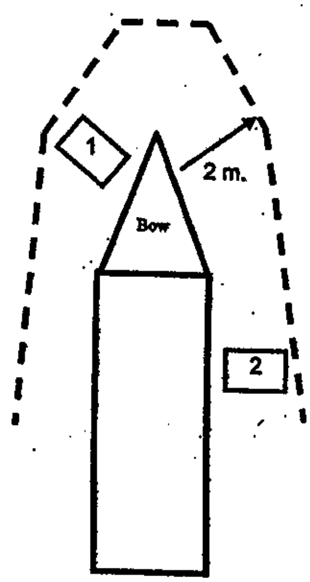
Longitude: 85D 51.324W

SUBSAMPLE SITE INFORMATION

	1	2
Water Depth @ Subsample Site:	5.6'	5.6'
Plant Density w/ Rake @ Subsample Site:	3	3

SPECIES INFORMATION

Species Code	V	R 1	R 2	QE	Voucher
MYRSPI	2	3	3	0	0
DOTDEC	1	-	1	0	0
CERDEM	1	-	1	0	0



Each subsampling area is 1.5 m long X 0.36 m wide.

Comments:

REMINDER INFORMATION

Substrate:
1 = Silt/Clay
2 = Silt w/Sand
3 = Sand w/Silt
4 = Hard Clay
5 = Gravel/Rock
6 = Sand

Marl
1 = Present
0 = absent

High Organic
1 = Present
0 = absent

Overall Surface Cover
N = Nonrooted floating
F = Floating, rooted
E = Emergent
S = Submersed

Canopy:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

Plant Density
0 = None
1 = 1-20%
2 = 21-40%
3 = 41-60%
4 = 61-80%
5 = 81-100%

V:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

R:
Blank=none
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2 = 21-40%
3 = 41-60%
4 = 61-80%
5 = 81-100%

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1 = Species suspecte
2 = Genus suspected
3 = Unknown

Voucher
0 = Not Taken
1 = Taken, not varified
2 = Taken, varified

Aquatic Vegetation Transect Site Data Sheet

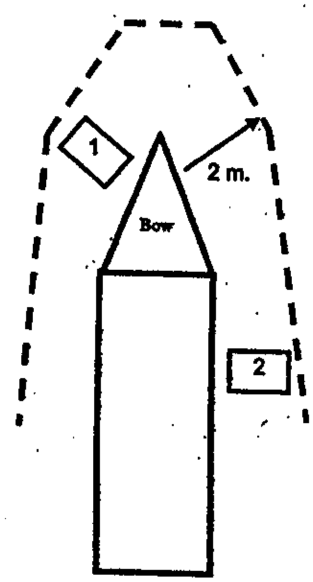
State of Indiana Department of Natural Resources

ORGANIZATION: V3 Consultants		DATE: 7/17/03	

SITE INFORMATION		SITE COORDINATES	
Transect ID: T2	Waterbody Name: Center Lake	Latitude: 41D 14.990 N	
Site ID: 03		Longitude: 85D 51.315W	
Substrate: 2	Waterbody ID:	SUBSAMPLE SITE INFORMATION	
Marl? 1	Total # of Species 3		
High Organic? 1	Canopy Abundance at Site		1 / 2
	S: 1 N: 0 F: 0 E: 0	Water Depth @ Subsample Site:	5.4' / 5.2'
		Plant Density w/ Rake @ Subsample Site:	4 / 1

SPECIES INFORMATION

Species Code	V	R 1	R 2	QE	Voucher
MYRSPI	1	2	1	0	0
CERDEM	+	3	-	0	0
POTPEC	+	1	-	0	0



Each subsampling area is 1.5 m long X 0.36 m wide.

Comments:

REMINDER INFORMATION

Substrate:
1 = Silt/Clay
2 = Silt w/Sand
3 = Sand w/Silt
4 = Hard Clay
5 = Gravel/Rock
6 = Sand

Marl
1 = Present
0 = absent

High Organic
1 = Present
0 = absent

Overall Surface Cover
N = Nonrooted floating
F = Floating, rooted
E = Emergent
S = Submersed

Canopy:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

Plant Density
0 = None
1 = 1-20%
2 = 21-40%
3 = 41-60%
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R:
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Aquatic Vegetation Transect Site Data Sheet

State of Indiana Department of Natural Resources

ORGANIZATION:	V3 Consultants	DATE:	7/17/03

SITE INFORMATION

Transect ID:	T2
Site ID:	04
Substrate:	1
Marl?	1
High Organic?	1
Waterbody Name:	Center Lake
Waterbody ID:	
Total # of Species	4

Canopy Abundance at Site

S:	N:	F:	E:
1	0	0	0

SITE COORDINATES

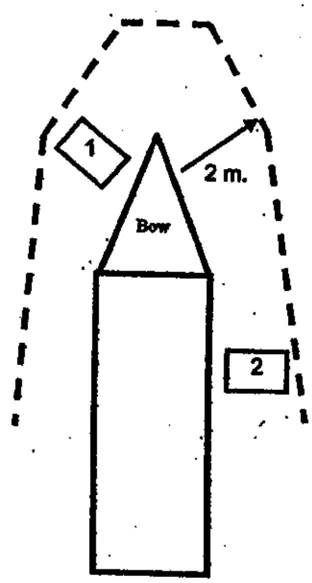
Latitude:	41D 15.046N
Longitude:	85D 51.304W

SUBSAMPLE SITE INFORMATION

	1	2
Water Depth @ Subsample Site:	3.9'	3.8'
Plant Density w/ Rake @ Subsample Site:	2	5

SPECIES INFORMATION

Species Code	V	R 1	R 2	QE	Voucher
POT PEC	1	–	–	0	0
MYR SPI	1	2	5	0	0
LEM MIN	1	–	–	0	0
CER DEM	1	–	2	0	0



Each subsampling area is 1.5 m long X 0.36 m wide.

Comments:

REMINDER INFORMATION

Substrate:
1 = Silt/Clay
2 = Silt w/Sand
3 = Sand w/Silt
4 = Hard Clay
5 = Gravel/Rock
6 = Sand

Marl
1 = Present
0 = absent

High Organic
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Overall Surface Cover
N = Nonrooted floating
F = Floating, rooted
E = Emergent
S = Submersed

Canopy:
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Plant Density
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1 = 1-20%
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Voucher
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Aquatic Vegetation Transect Site Data Sheet

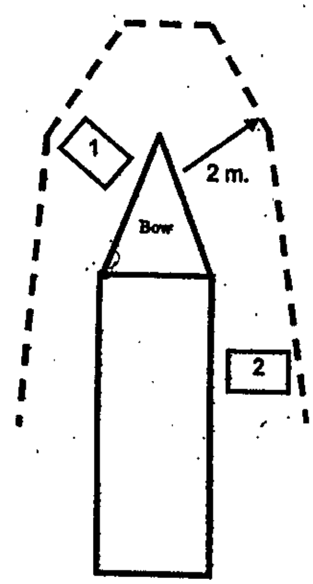
State of Indiana Department of Natural Resources

ORGANIZATION:	V3 Consultants	DATE:	7/17/03

SITE INFORMATION		SITE COORDINATES		
Transect ID: T2	Waterbody Name: Center Lake	Latitude:	41D 15.079N	
Site ID: 05		Longitude:	85D 51.306W	
Substrate: 2	Waterbody ID:	SUBSAMPLE SITE INFORMATION		
Marl? 1	Total # of Species 8		1	2
High Organic? 1	Canopy Abundance at Site	Water Depth @ Subsample Site:	1.5'	1.5'
	S: 1 N: 1 F: 1 E: 3	Plant Density w/ Rake @ Subsample Site:	5	1

SPECIES INFORMATION

Species Code	V	R 1	R 2	QE	Voucher
TYPANG	2	—	—	0	0
CEDOCC	1	—	—	0	0
HIBPAL	2	—	—	0	0
MYRSPI	1	2	4	0	0
NYMODO	2	—	—	0	0
POTPEC	1	—	—	0	0
LEMMIN	1	—	—	0	0
CERDEM	4	5	1	0	0



Each subsampling area is 1.5 m long X 0.36 m wide.

Comments:

1m from shore

REMINDER INFORMATION

Substrate:
1 = Silt/Clay
2 = Silt w/Sand
3 = Sand w/Silt
4 = Hard Clay
5 = Gravel/Rock
6 = Sand

Marl
1 = Present
0 = absent

High Organic
1 = Present
0 = absent

Overall Surface Cover
N = Nonrooted floating
F = Floating, rooted
E = Emergent
S = Submersed

Canopy:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

Plant Density
0 = None
1 = 1-20%
2 = 21-40%
3 = 41-60%
4 = 61-80%
5 = 81-100%

V:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

R:
Blank=none
1 = 1-20%
2 = 21-40%
3 = 41-60%
4 = 61-80%
5 = 81-100%

QE Code:
0 = as defined
1 = Species suspecte
2 = Genus suspected
3 = Unknown

Voucher
0 = Not Taken
1 = Taken, not varified
2 = Taken, varified

Aquatic Vegetation Transect Site Data Sheet

State of Indiana Department of Natural Resources

ORGANIZATION:	V3 Consultants	DATE:	7/17/03

SITE INFORMATION

Transect ID:	T3	Waterbody Name: Center Lake	
Site ID:	01		
Substrate:	5	Waterbody ID:	
Marl?	0	Total # of Species	0
High Organic?	0	CanopyAbundance at Site	
		S: 0 N: 0 F: 0 E: 0	

SITE COORDINATES

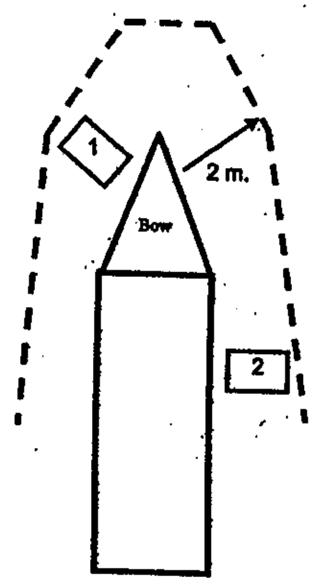
Latitude:	41D 14.819N
Longitude:	85D 51.223W

SUBSAMPLE SITE INFORMATION

	1	2
Water Depth @ Subsample Site:	1'	1.3'
Plant Density w/ Rake @ Subsample Site:	0	0

SPECIES INFORMATION

Species Code	V	R 1	R 2	QE	Voucher
NOAQVG	–	1	1	–	–



Each subsampling area is 1.5 m long X 0.36 m wide.

Comments:

Retaining wall shoreline Treatment

REMINDER INFORMATION

Substrate:
1 = Silt/Clay
2 = Silt w/Sand
3 = Sand w/Silt
4 = Hard Clay
5 = Gravel/Rock
6 = Sand

Marl
1 = Present
0 = absent

High Organic
1 = Present
0 = absent

Overall Surface Cover
N = Nonrooted floating
F = Floating, rooted
E = Emergent
S = Submersed

Canopy:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

Plant Density
0 = None
1 = 1-20%
2 = 21-40%
3 = 41-60%
4 = 61-80%
5 = 81-100%

V:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

R:
Blank=none
1 = 1-20%
2 = 21-40%
3 = 41-60%
4 = 61-80%
5 = 81-100%

QE Code:
0 = as defined
1 = Species suspecte
2 = Genus suspected
3 = Unknown

Voucher
0 = Not Taken
1 = Taken, not varified
2 = Taken, varified

Aquatic Vegetation Transect Site Data Sheet

State of Indiana Department of Natural Resources

ORGANIZATION:	V3 Consultants	DATE:	7/17/03

SITE INFORMATION

Transect ID:	T3	Waterbody Name:	Center Lake
Site ID:	02		
Substrate:	2	Waterbody ID:	
Marl?	0	Total # of Species	1
High Organic?	0		

Canopy Abundance at Site

S:	N:	F:	E:
0	0	0	0

SITE COORDINATES

Latitude: 41D 14.822N

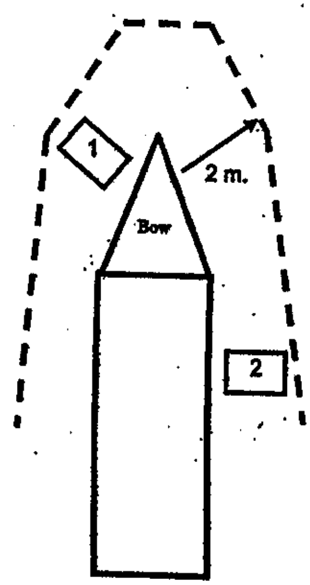
Longitude: 85D 51.228W

SUBSAMPLE SITE INFORMATION

	1	2
Water Depth @ Subsample Site:	2.3'	2.6'
Plant Density w/ Rake @ Subsample Site:	1	0

SPECIES INFORMATION

Species Code	V	R 1	R 2	QE	Voucher
CERDEM	1	1	-	0	0



Each subsampling area is 1.5 m long X 0.36 m wide.

Comments:

Fairly unveg. near retaining wall

REMINDER INFORMATION

Substrate:
1 = Silt/Clay
2 = Silt w/Sand
3 = Sand w/Silt
4 = Hard Clay
5 = Gravel/Rock
6 = Sand

Marl
1 = Present
0 = absent

High Organic
1 = Present
0 = absent

Overall Surface Cover
N = Nonrooted floating
F = Floating, rooted
E = Emergent
S = Submersed

Canopy:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

Plant Density
0 = None
1 = 1-20%
2 = 21-40%
3 = 41-60%
4 = 61-80%
5 = 81-100%

V:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

R:
Blank=none
1 = 1-20%
2 = 21-40%
3 = 41-60%
4 = 61-80%
5 = 81-100%

QE Code:
0 = as defined
1 = Species suspecte
2 = Genus suspected
3 = Unknown

Voucher
0 = Not Taken
1 = Taken, not varified
2 = Taken, varified

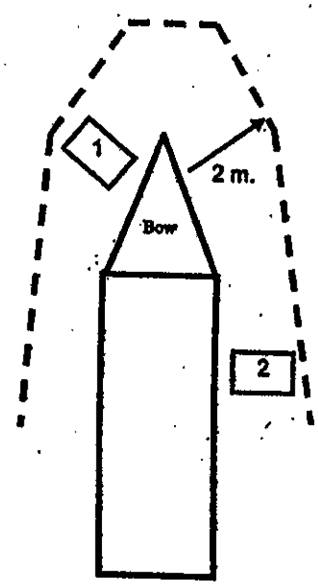
Aquatic Vegetation Transect Site Data Sheet

State of Indiana Department of Natural Resources

ORGANIZATION: V3 Consultants		DATE: 7/17/03	
SITE INFORMATION		SITE COORDINATES	
Transect ID: T3	Waterbody Name: Center Lake	Latitude: 41D 14.823N	
Site ID: 03		Longitude: 85D 51.234W	
Substrate: 2	Waterbody ID:	SUBSAMPLE SITE INFORMATION	
Marl? 0	Total # of Species 4		
High Organic? 1		1	2
	CanopyAbundance at Site: S: 3, N: 0, F: 0, E: 0	Water Depth @ Subsample Site: 3.8'	4.0'
		Plant Density w/ Rake @ Subsample Site: 3	5

SPECIES INFORMATION

Species Code	V	R 1	R 2	QE	Voucher
POTILL	3	3	4	0	0
MYRSPI	1	1	1	0	0
CERDEM	1	1	1	0	0
POTAMP	1	-	1	0	0



Each subsampling area is 1.5 m long X 0.36 m wide.

Comments:

REMINDER INFORMATION

Substrate:
1 = Silt/Clay
2 = Silt w/Sand
3 = Sand w/Silt
4 = Hard Clay
5 = Gravel/Rock
6 = Sand

Marl
1 = Present
0 = absent

High Organic
1 = Present
0 = absent

Overall Surface Cover
N = Nonrooted floating
F = Floating, rooted
E = Emergent
S = Submersed

Canopy:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

Plant Density
0 = None
1 = 1-20%
2 = 21-40%
3 = 41-60%
4 = 61-80%
5 = 81-100%

V:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

R:
Blank=none
1 = 1-20%
2 = 21-40%
3 = 41-60%
4 = 61-80%
5 = 81-100%

QE Code:
0 = as defined
1 = Species suspecte
2 = Genus suspected
3 = Unknown

Voucher
0 = Not Taken
1 = Taken, not varified
2 = Taken, varified

Aquatic Vegetation Transect Site Data Sheet

State of Indiana Department of Natural Resources

ORGANIZATION: V3 Consultants

DATE: 7/17/03

SITE INFORMATION		SITE COORDINATES	
Transect ID: T3	Waterbody Name: Center Lake	Latitude:	41D 14.821N
Site ID: 04		Longitude:	85D 51.235W
Substrate: 2	Waterbody ID:		
Marl? 0	Total # of Species 4		
High Organic? 1			

SUBSAMPLE SITE INFORMATION

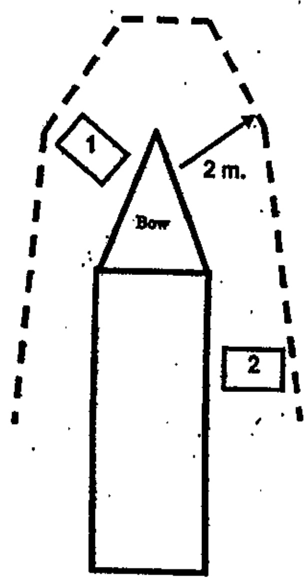
	1	2
Water Depth @ Subsample Site:	38'	38'
Plant Density w/ Rake @ Subsample Site:	5	5

Canopy Abundance at Site

S:	N:	F:	E:
3	0	0	0

SPECIES INFORMATION

Species Code	V	R 1	R 2	QE	Voucher
MYRSPI	2	-	1	0	0
POTILL	3	4	4	0	0
POTPEC	1	-	1	0	0
CERDEM	1	1	1	0	0



Each subsampling area is 1.5 m long X 0.36 m wide.

Comments:

REMINDER INFORMATION

Substrate:
1 = Silt/Clay
2 = Silt w/Sand
3 = Sand w/Silt
4 = Hard Clay
5 = Gravel/Rock
6 = Sand

Marl
1 = Present
0 = absent

High Organic
1 = Present
0 = absent

Overall Surface Cover
N = Nonrooted floating
F = Floating, rooted
E = Emergent
S = Submersed

Canopy:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

Plant Density
0 = None
1 = 1-20%
2 = 21-40%
3 = 41-60%
4 = 61-80%
5 = 81-100%

V:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

R:
Blank=none
1 = 1-20%
2 = 21-40%
3 = 41-60%
4 = 61-80%
5 = 81-100%

QE Code:
0 = as defined
1 = Species suspecte
2 = Genus suspected
3 = Unknown

Voucher
0 = Not Taken
1 = Taken, not varified
2 = Taken, varified

Aquatic Vegetation Transect Site Data Sheet

State of Indiana Department of Natural Resources

ORGANIZATION:	V3 Consultants	DATE:	7/17/03

SITE INFORMATION		SITE COORDINATES	
Transect ID: T3	Waterbody Name: Center Lake	Latitude:	41D 14.819N
Site ID: 05		Longitude:	85D 51.244W
Substrate: 1	Waterbody ID:		
Marl? 1	Total # of Species 2		
High Organic? 1			

Canopy Abundance at Site

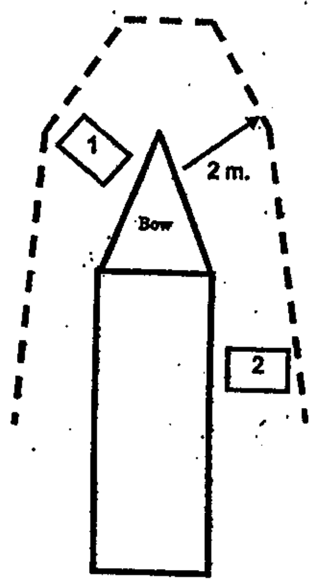
S:	N:	F:	E:
2	0	0	0

SUBSAMPLE SITE INFORMATION

	1	2
Water Depth @ Subsample Site:	7.7'	7.7'
Plant Density w/ Rake @ Subsample Site:	3	5

SPECIES INFORMATION

Species Code	V	R 1	R 2	QE	Voucher
POT ILL	2	3	4	0	0
CERDEM	1	1	1	0	0



Each subsampling area is 1.5 m long X 0.36 m wide.

Comments:

100' from shore

REMINDER INFORMATION

Substrate:
1 = Silt/Clay
2 = Silt w/Sand
3 = Sand w/Silt
4 = Hard Clay
5 = Gravel/Rock
6 = Sand

Marl
1 = Present
0 = absent

High Organic
1 = Present
0 = absent

Overall Surface Cover
N = Nonrooted floating
F = Floating, rooted
E = Emergent
S = Submersed

Canopy:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

Plant Density
0 = None
1 = 1-20%
2 = 21-40%
3 = 41-60%
4 = 61-80%
5 = 81-100%

V:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

R:
Blank=none
1 = 1-20%
2 = 21-40%
3 = 41-60%
4 = 61-80%
5 = 81-100%

QE Code:
0 = as defined
1 = Species suspecte
2 = Genus suspected
3 = Unknown

Voucher
0 = Not Taken
1 = Taken, not varified
2 = Taken, varified

Transect Summary Data

Transect ID: T4

Dom. Substrate: 1 | # of Sites (usually 5): 5 | Total # of Species: 10

Transect Start Coordinates
Latitude (DD): 41°15.006N
Longitude (DD): 085°51.471W

Transect End Coordinates
Latitude (DD): 41°14.948N
Longitude (DD): 85°51.392W

Notable Landmark(s):

Transect Summary Data

Transect ID: T5

Dom. Substrate: 2 | # of Sites (usually 5): 5 | Total # of Species: 5

Transect Start Coordinates
Latitude (DD): 41°14.623N
Longitude (DD): 085°51.226W

Transect End Coordinates
Latitude (DD): 41°14.630N
Longitude (DD): 85°51.227W

Notable Landmark(s):

Transect Summary Data

Transect ID: T6

Dom. Substrate: 2 | # of Sites (usually 5): 3 | Total # of Species: 7

Transect Start Coordinates
Latitude (DD): 41°14.544N
Longitude (DD): 85°51.391W

Transect End Coordinates
Latitude (DD): 41°14.548N
Longitude (DD): 85°51.390W

Notable Landmark(s):

Aquatic Vegetation Transect Site Data Sheet

State of Indiana Department of Natural Resources

ORGANIZATION: V3 Consultants

DATE: 7/18/03

SITE INFORMATION		SITE COORDINATES	
Transect ID: T4	Waterbody Name: Center Lake	Latitude:	41° 15.006 N
Site ID: 01		Longitude:	085° 51.471 W
Substrate: 2	Waterbody ID:		
Marl? 1	Total # of Species 10		
High Organic? 1			

Canopy Abundance at Site

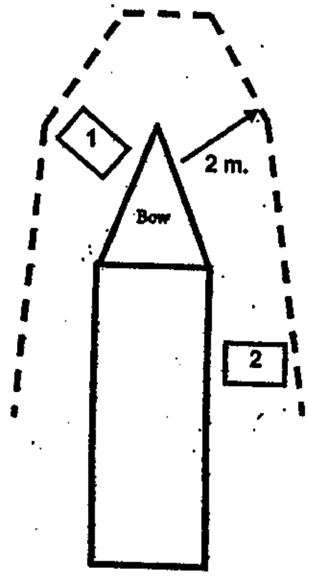
S:	N:	F:	E:
2	1	4	2

SUBSAMPLE SITE INFORMATION

	1	2
Water Depth @ Subsample Site:	1.0'	1.4'
Plant Density w/ Rake @ Subsample Site:	3	3

SPECIES INFORMATION

Species Code	V	R 1	R 2	QE	Voucher
POTNOD	2	1	1	0	0
NYMODO	4	1	1	0	0
TYPANG	2	–	1	0	0
VITRIP	1	–	–	0	0
MYRSPI	1	1	1	0	0
CARCOM	1	–	–	0	0
LEMMIN	1	1	–	0	0
WOLCOL	1	–	–	0	0
CERDEM	1	1	2	0	0
POTPEC	1	1	1	0	0



Each subsampling area is 1.5 m long X 0.36 m wide.

Comments:

REMINDER INFORMATION

Substrate:
1 = Silt/Clay
2 = Silt w/Sand
3 = Sand w/Silt
4 = Hard Clay
5 = Gravel/Rock
6 = Sand

Marl
1 = Present
0 = absent

High Organic
1 = Present
0 = absent

Overall Surface Cover
N = Nonrooted floating
F = Floating, rooted
E = Emergent
S = Submersed

Canopy:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

Plant Density
0 = None
1 = 1-20%
2 = 21-40%
3 = 41-60%
4 = 61-80%
5 = 81-100%

V:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

R:
Blank=none
1 = 1-20%
2 = 21-40%
3 = 41-60%
4 = 61-80%
5 = 81-100%

QE Code:
0 = as defined
1 = Species suspecte
2 = Genus suspected
3 = Unknown

Voucher
0 = Not Taken
1 = Taken, not varified
2 = Taken, varified

Aquatic Vegetation Transect Site Data Sheet

State of Indiana Department of Natural Resources

ORGANIZATION: V3 Consultants

DATE: 7/18/03

SITE INFORMATION

Transect ID: T4

Site ID: 02

Substrate: 2

Marl? 1

High Organic? 1

Waterbody Name: Center Lake

Waterbody ID:

Total # of Species 5

Canopy Abundance at Site

S:	N:	F:	E:
1	1	0	0

SITE COORDINATES

Latitude: 41° 14.992N

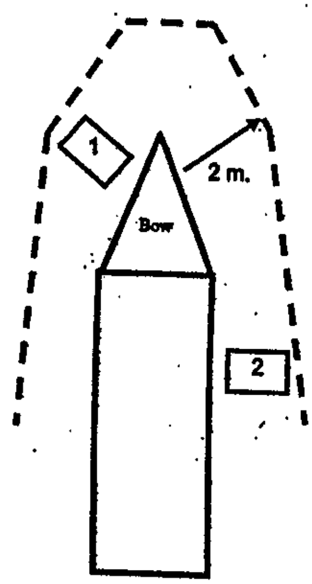
Longitude: 85° 51.450W

SUBSAMPLE SITE INFORMATION

	1	2
Water Depth @ Subsample Site:	4.1'	3.9'
Plant Density w/ Rake @ Subsample Site:	5	5

SPECIES INFORMATION

Species Code	V	R 1	R 2	QE	Voucher
MYRSPI	1	4	5	0	0
LEMMIN	1	–	–	0	0
WOLCOL	1	–	–	0	0
POTPEC	1	1	–	0	0
CERDEM	1	1	1	0	0



Each subsampling area is 1.5 m long X 0.36 m wide.

Comments:

REMINDER INFORMATION

Substrate:
1 = Silt/Clay
2 = Silt w/Sand
3 = Sand w/Silt
4 = Hard Clay
5 = Gravel/Rock
6 = Sand

Marl
1 = Present
0 = absent

High Organic
1 = Present
0 = absent

Overall Surface Cover
N = Nonrooted floating
F = Floating, rooted
E = Emergent
S = Submersed

Canopy:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

Plant Density
0 = None
1 = 1-20%
2 = 21-40%
3 = 41-60%
4 = 61-80%
5 = 81-100%

V:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

R:
Blank=none
1 = 1-20%
2 = 21-40%
3 = 41-60%
4 = 61-80%
5 = 81-100%

QE Code:
0 = as defined
1 = Species suspecte
2 = Genus suspected
3 = Unknown

Voucher
0 = Not Taken
1 = Taken, not varified
2 = Taken, varified

Aquatic Vegetation Transect Site Data Sheet

State of Indiana Department of Natural Resources

ORGANIZATION: V3 Consultants

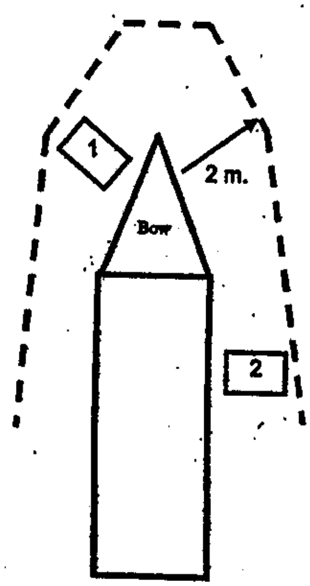
DATE: 7/18/03

SITE INFORMATION				
Transect ID: T4	Waterbody Name: Center Lake			
Site ID: 03				
Substrate: 1	Waterbody ID:			
Marl? 1	Total # of Species 5			
High Organic? 0	Canopy Abundance at Site			
	S: 1	N: 1	F: 0	E: 0

SITE COORDINATES		
Latitude:	41° 14.975N	
Longitude:	85° 51.428W	
SUBSAMPLE SITE INFORMATION	**1**	**2**
Water Depth @ Subsample Site:	4.8'	4.8'
Plant Density w/ Rake @ Subsample Site:	5	4

SPECIES INFORMATION

Species Code	V	R 1	R 2	QE	Voucher
WOLCOL	1	–	–	0	0
LEMMIN	1	–	–	0	0
POTPEC	1	1	1	0	0
MYRSPI	1	4	4	0	0
CERDEM	1	1	–	0	0



Each subsampling area is 1.5 m long X 0.36 m wide.

Comments:

REMINDER INFORMATION

Substrate:
1 = Silt/Clay
2 = Silt w/Sand
3 = Sand w/Silt
4 = Hard Clay
5 = Gravel/Rock
6 = Sand

Marl
1 = Present
0 = absent

High Organic
1 = Present
0 = absent

Overall Surface Cover
N = Nonrooted floating
F = Floating, rooted
E = Emergent
S = Submersed

Canopy:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

Plant Density
0 = None
1 = 1-20%
2 = 21-40%
3 = 41-60%
4 = 61-80%
5 = 81-100%

V:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

R:
Blank=none
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2 = 21-40%
3 = 41-60%
4 = 61-80%
5 = 81-100%

QE Code:
0 = as defined
1 = Species suspecte
2 = Genus suspected
3 = Unknown

Voucher
0 = Not Taken
1 = Taken, not varified
2 = Taken, varified

Aquatic Vegetation Transect Site Data Sheet

State of Indiana Department of Natural Resources

ORGANIZATION: V3 Consultants

DATE: 7/18/03

SITE INFORMATION

Transect ID:	T4
Site ID:	04
Substrate:	1
Marl?	1
High Organic?	0

Waterbody Name: Center Lake

Waterbody ID:

Total # of Species: 4

Canopy Abundance at Site

S:	N:	F:	E:
1	1	0	0

SITE COORDINATES

Latitude: 41° 14.962 N

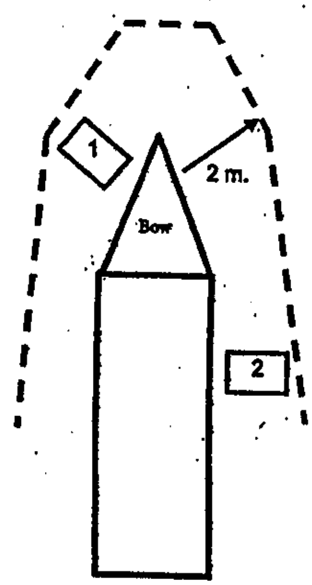
Longitude: 85° 51.410 W

SUBSAMPLE SITE INFORMATION

	1	2
Water Depth @ Subsample Site:	5.2'	5.1'
Plant Density w/ Rake @ Subsample Site:	4	5

SPECIES INFORMATION

Species Code	V	R 1	R 2	QE	Voucher
MYRSPI	1	4	4	0	0
LEMMIN	1	–	–	0	0
CERDEM	1	1	1	0	0
POTPEC	1	1	–	0	0



Each subsampling area is 1.5 m long X 0.36 m wide.

Comments:

REMINDER INFORMATION

Substrate:
1 = Silt/Clay
2 = Silt w/Sand
3 = Sand w/Silt
4 = Hard Clay
5 = Gravel/Rock
6 = Sand

Marl
1 = Present
0 = absent

High Organic
1 = Present
0 = absent

Overall Surface Cover
N = Nonrooted floating
F = Floating, rooted
E = Emergent
S = Submersed

Canopy:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

Plant Density
0 = None
1 = 1-20%
2 = 21-40%
3 = 41-60%
4 = 61-80%
5 = 81-100%

V:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

R:
Blank=none
1 = 1-20%
2 = 21-40%
3 = 41-60%
4 = 61-80%
5 = 81-100%

QE Code:
0 = as defined
1 = Species suspecte
2 = Genus suspected
3 = Unknown

Voucher
0 = Not Taken
1 = Taken, not varified
2 = Taken, varified

Aquatic Vegetation Transect Site Data Sheet

State of Indiana Department of Natural Resources

ORGANIZATION: V3 Consultants

DATE: 7/18/03

SITE INFORMATION

Transect ID:	T4
Site ID:	05
Substrate:	1
Marl?	1
High Organic?	1

Waterbody Name: Center Lake

Waterbody ID:

Total # of Species: 2

Canopy Abundance at Site

S:	N:	F:	E:
0	0	0	0

SITE COORDINATES

Latitude: 41° 14.948 N

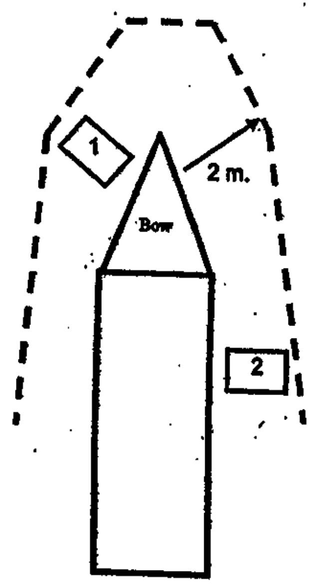
Longitude: 85° 51.372 W

SUBSAMPLE SITE INFORMATION

	1	2
Water Depth @ Subsample Site:	7.1'	7.0'
Plant Density w/ Rake @ Subsample Site:	4	1

SPECIES INFORMATION

Species Code	V	R 1	R 2	QE	Voucher
CERDEM	1	4	1	0	0
POT PEC	1	1	1	0	0



Each subsampling area is 1.5 m long X 0.36 m wide.

Comments: 328' from shoreline (01)

REMINDER INFORMATION

Substrate:
1 = Silt/Clay
2 = Silt w/Sand
3 = Sand w/Silt
4 = Hard Clay
5 = Gravel/Rock
6 = Sand

Marl
1 = Present
0 = absent

High Organic
1 = Present
0 = absent

Overall Surface Cover
N = Nonrooted floating
F = Floating, rooted
E = Emergent
S = Submersed

Canopy:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

Plant Density
0 = None
1 = 1-20%
2 = 21-40%
3 = 41-60%
4 = 61-80%
5 = 81-100%

V:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

R:
Blank=none
1 = 1-20%
2 = 21-40%
3 = 41-60%
4 = 61-80%
5 = 81-100%

QE Code:
0 = as defined
1 = Species suspects
2 = Genus suspected
3 = Unknown

Voucher
0 = Not Taken
1 = Taken, not varified
2 = Taken, varified

Aquatic Vegetation Transect Site Data Sheet

State of Indiana Department of Natural Resources

ORGANIZATION: V3 Consultants

DATE: 7/18/03

SITE INFORMATION

Transect ID:	T5
Site ID:	01
Substrate:	5
Marl?	0
High Organic?	0

Waterbody Name: Center Lake

Waterbody ID:

Total # of Species: 5

Canopy Abundance at Site

S:	N:	F:	E:
1	1	2	0

SITE COORDINATES

Latitude: 41° 14.623 N

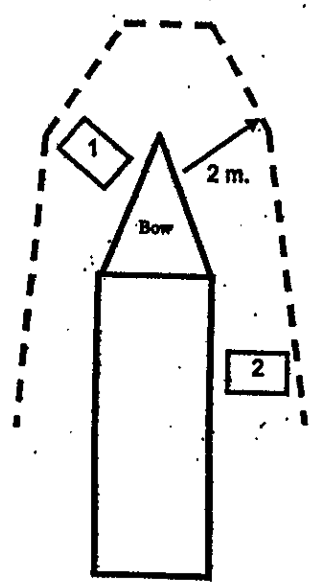
Longitude: 85° 51.226 W

SUBSAMPLE SITE INFORMATION

	1	2
Water Depth @ Subsample Site:	0.7'	0.8'
Plant Density w/ Rake @ Subsample Site:	0	4

SPECIES INFORMATION

Species Code	V	R 1	R 2	QE	Voucher
NYMODO	2	—	1	0	0
MYRSPI	1	—	1	0	0
POTILL	1	—	1	0	0
CERDEM	1	—	4	0	0
LEMMIN	1	—	1	0	0



Each subsampling area is 1.5 m long X 0.36 m wide.

Comments:

Near Public Beach

REMINDER INFORMATION

Substrate:
1 = Silt/Clay
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5 = Gravel/Rock
6 = Sand

Marl
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High Organic
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0 = absent

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F = Floating, rooted
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S = Submersed

Canopy:
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4 = > 60%

Plant Density
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4 = > 60%

R:
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QE Code:
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1 = Species suspecte
2 = Genus suspected
3 = Unknown

Voucher
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1 = Taken, not varified
2 = Taken, varified

Aquatic Vegetation Transect Site Data Sheet

State of Indiana Department of Natural Resources

ORGANIZATION:	V3 Consultants	DATE:	7/18/03

SITE INFORMATION

Transect ID:	TS	Waterbody Name:	Center Lake
Site ID:	02		
Substrate:	2	Waterbody ID:	
Marl?	0	Total # of Species	4
High Organic?	1		

CanopyAbundance at Site

S:	N:	F:	E:
2	0	2	0

SITE COORDINATES

Latitude: 41° 14.627 N

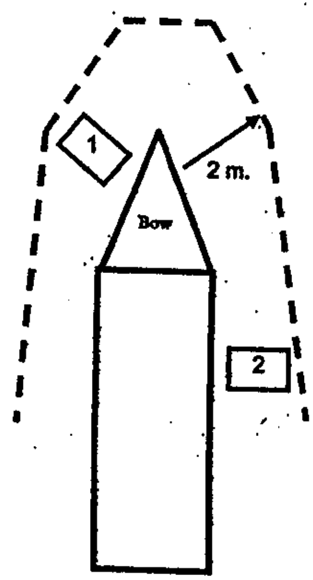
Longitude: 85° 51.221 W

SUBSAMPLE SITE INFORMATION

	1	2
Water Depth @ Subsample Site:	3.3'	3.8'
Plant Density w/ Rake @ Subsample Site:	2	4

SPECIES INFORMATION

Species Code	V	R 1	R 2	QE	Voucher
NYMODO	2	–	–	0	0
POTILL	2	2	2	0	0
CERDEM	1	1	2	0	0
MYRSPI	1	–	1	0	0



Each subsampling area is 1.5 m long X 0.36 m wide.

Comments:

REMINDER INFORMATION

Substrate:
1 = Silt/Clay
2 = Silt w/Sand
3 = Sand w/Silt
4 = Hard Clay
5 = Gravel/Rock
6 = Sand

Marl
1 = Present
0 = absent

High Organic
1 = Present
0 = absent

Overall Surface Cover
N = Nonrooted floating
F = Floating, rooted
E = Emergent
S = Submersed

Canopy:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

Plant Density
0 = None
1 = 1-20%
2 = 21-40%
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V:
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2 = 2-20%
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4 = > 60%

R:
Blank=none
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2 = 21-40%
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QE Code:
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1 = Species suspecte
2 = Genus suspected
3 = Unknown

Voucher
0 = Not Taken
1 = Taken, not varified
2 = Taken, varified

Aquatic Vegetation Transect Site Data Sheet

State of Indiana Department of Natural Resources

ORGANIZATION: V3 Consultants

DATE: 7/18/03

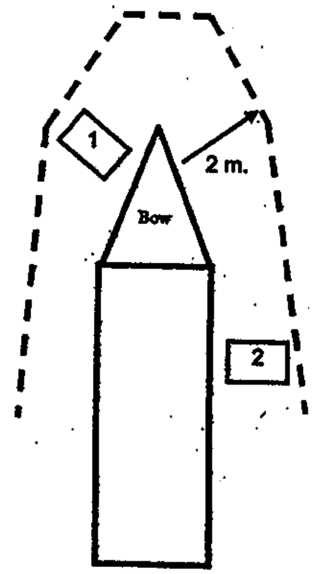
SITE INFORMATION		
Transect ID: T5	Waterbody Name: Center Lake	
Site ID: 03		
Substrate: 2	Waterbody ID:	
Marl? 1	Total # of Species 3	
High Organic? 1	CanopyAbundance at Site	
	S: 2 N: 0 F: 3 E: 0	

SITE COORDINATES	
Latitude:	41° 14.628N
Longitude:	85° 51.224W

SUBSAMPLE SITE INFORMATION	1	2
Water Depth @ Subsample Site:	4.3'	3.9'
Plant Density w/ Rake @ Subsample Site:	3	3

SPECIES INFORMATION

Species Code	V	R 1	R 2	QE	Voucher
POTILL	3	3	2	0	0
MYRSPI	1	—	—	0	0
CERDEM	1	1	2	0	0



Each subsampling area is 1.5 m long X 0.36 m wide.

Comments:

REMINDER INFORMATION

Substrate:
1 = Silt/Clay
2 = Silt w/Sand
3 = Sand w/Silt
4 = Hard Clay
5 = Gravel/Rock
6 = Sand

Marl
1 = Present
0 = absent

High Organic
1 = Present
0 = absent

Overall Surface Cover
N = Nonrooted floating
F = Floating, rooted
E = Emergent
S = Submersed

Canopy:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

Plant Density
0 = None
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2 = 21-40%
3 = 41-60%
4 = 61-80%
5 = 81-100%

V:
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2 = 2-20%
3 = 21-60%
4 = > 60%

R:
Blank=none
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2 = 21-40%
3 = 41-60%
4 = 61-80%
5 = 81-100%

QE Code:
0 = as defined
1 = Species suspecte
2 = Genus suspected
3 = Unknown

Voucher
0 = Not Taken
1 = Taken, not varified
2 = Taken, varified

Aquatic Vegetation Transect Site Data Sheet

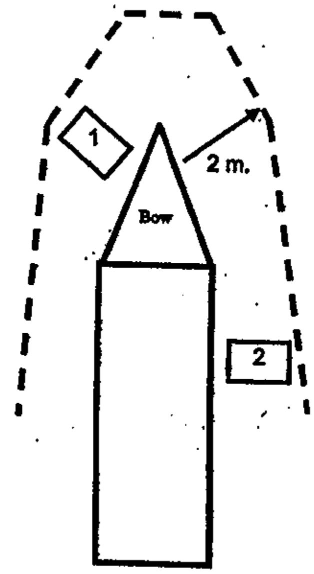
State of Indiana Department of Natural Resources

ORGANIZATION: V3 Consultants | DATE: 7/18/03

SITE INFORMATION		SITE COORDINATES	
Transect ID: T5	Waterbody Name: Center Lake	Latitude:	41° 14.630 N
Site ID: 04		Longitude:	85° 51.224 W
Substrate: 1	Waterbody ID:	SUBSAMPLE SITE INFORMATION	
Marl? 1	Total # of Species 1		
High Organic? 1	Canopy Abundance at Site		1 / 2
	S: 0 N: 0 F: 0 E: 0	Water Depth @ Subsample Site:	4.8' / 5.1'
		Plant Density w/ Rake @ Subsample Site:	1 / 4

SPECIES INFORMATION

Species Code	V	R 1	R 2	QE	Voucher
CERDEM	1	1	4	0	0



Each subsampling area is 1.5 m long X 0.36 m wide.

Comments:

REMINDER INFORMATION

Substrate:
1 = Silt/Clay
2 = Silt w/Sand
3 = Sand w/Silt
4 = Hard Clay
5 = Gravel/Rock
6 = Sand

Marl
1 = Present
0 = absent

High Organic
1 = Present
0 = absent

Overall Surface Cover
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E = Emergent
S = Submersed

Canopy:
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4 = > 60%

Plant Density
0 = None
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2 = 21-40%
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5 = 81-100%

V:
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2 = 2-20%
3 = 21-60%
4 = > 60%

R:
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2 = 21-40%
3 = 41-60%
4 = 61-80%
5 = 81-100%

QE Code:
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1 = Species suspecte
2 = Genus suspected
3 = Unknown

Voucher
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1 = Taken, not varified
2 = Taken, varified

Aquatic Vegetation Transect Site Data Sheet

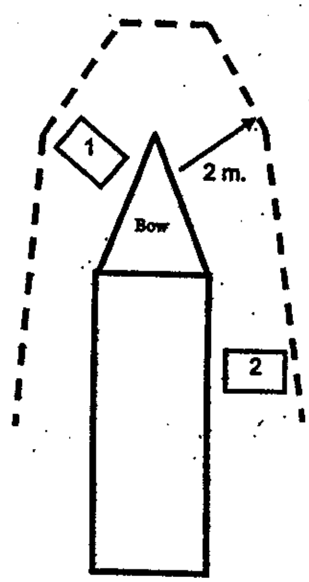
State of Indiana Department of Natural Resources

ORGANIZATION: V3 Consultants	DATE: 7/18/09

SITE INFORMATION		SITE COORDINATES		
Transect ID: T5	Waterbody Name: Center Lake	Latitude: 41° 14.630 N		
Site ID: 05		Longitude: 85° 51.227 W		
Substrate: 1	Waterbody ID:	SUBSAMPLE SITE INFORMATION		
Marl? 1	Total # of Species 2		1	2
High Organic? 1	CanopyAbundance at Site	Water Depth @ Subsample Site:	5.7'	5.2'
	S: 0 N: 1 F: 0 E: 0	Plant Density w/ Rake @ Subsample Site:	1	0

SPECIES INFORMATION

Species Code	V	R 1	R 2	QE	Voucher
LEMMIN	1	-	-	0	0
CERDEM	1	-	1	0	0



Each subsampling area is 1.5 m long X 0.36 m wide.

Comments:

REMINDER INFORMATION

Substrate:
1 = Silt/Clay
2 = Silt w/Sand
3 = Sand w/Silt
4 = Hard Clay
5 = Gravel/Rock
6 = Sand

Marl
1 = Present
0 = absent

High Organic
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0 = absent

Overall Surface Cover
N = Nonrooted floating
F = Floating, rooted
E = Emergent
S = Submersed

Canopy:
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4 = > 60%

Plant Density
0 = None
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2 = 21-40%
3 = 41-60%
4 = 61-80%
5 = 81-100%

V:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

R:
Blank=none
1 = 1-20%
2 = 21-40%
3 = 41-60%
4 = 61-80%
5 = 81-100%

QE Code:
0 = as defined
1 = Species suspecte
2 = Genus suspected
3 = Unknown

Voucher
0 = Not Taken
1 = Taken, not varified
2 = Taken, varified

Aquatic Vegetation Transect Site Data Sheet

State of Indiana Department of Natural Resources

ORGANIZATION: V3 Consultants

DATE: 7/18/03

SITE INFORMATION		SITE COORDINATES	
Transect ID: T6	Waterbody Name: Center Lake	Latitude:	41° 14.544N
Site ID: 01		Longitude:	85° 51.371W
Substrate: 2	Waterbody ID:		
Marl? 0	Total # of Species 7		
High Organic? 0			

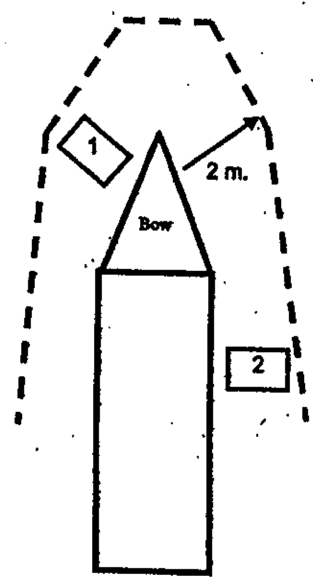
Canopy Abundance at Site: S: 1 N: 1 F: 3 E: 3

SUBSAMPLE SITE INFORMATION

	1	2
Water Depth @ Subsample Site:	0.9'	0.8'
Plant Density w/ Rake @ Subsample Site:	1	1

SPECIES INFORMATION

Species Code	V	R 1	R 2	QE	Voucher
SCIAME	3	–	–	0	0
NYM ODO	3	1	1	0	0
LEM MIN	1	–	–	0	0
WOL COL	1	–	–	0	0
MYRSPI	1	–	–	0	0
CER DEM	1	1	1	0	0
POTILL	1	–	1	0	0



Each subsampling area is 1.5 m long X 0.36 m wide.

Comments:

Boat Launch

REMINDER INFORMATION

Substrate:
1 = Silt/Clay
2 = Silt w/Sand
3 = Sand w/Silt
4 = Hard Clay
5 = Gravel/Rock
6 = Sand

Marl
1 = Present
0 = absent

High Organic
1 = Present
0 = absent

Overall Surface Cover
N = Nonrooted floating
F = Floating, rooted
E = Emergent
S = Submersed

Canopy:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

Plant Density
0 = None
1 = 1-20%
2 = 21-40%
3 = 41-60%
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5 = 81-100%

V:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

R:
Blank=none
1 = 1-20%
2 = 21-40%
3 = 41-60%
4 = 61-80%
5 = 81-100%

QE Code:
0 = as defined
1 = Species suspecte
2 = Genus suspected
3 = Unknown

Voucher
0 = Not Taken
1 = Taken, not varified
2 = Taken, varified

Aquatic Vegetation Transect Site Data Sheet

State of Indiana Department of Natural Resources

ORGANIZATION:	V3 Consultants	DATE:	7/18/03

SITE INFORMATION

Transect ID: 76	Waterbody Name: Center Lake	
Site ID: 02		
Substrate: 2	Waterbody ID:	
Marl? 0	Total # of Species 5	
High Organic? 1	Canopy Abundance at Site	
	S: 1	N: 1	F: 3	E: 0

SITE COORDINATES

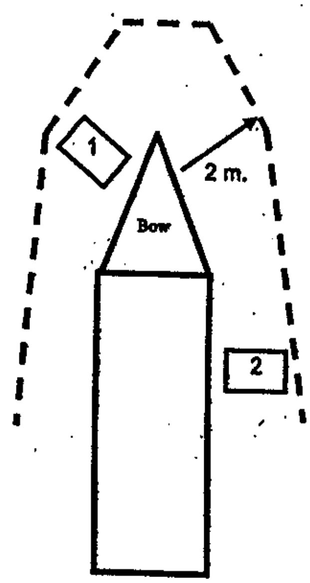
Latitude:	41° 14.544N
Longitude:	85° 51.309 W

SUBSAMPLE SITE INFORMATION

	1	2
Water Depth @ Subsample Site:	3.0'	2.1'
Plant Density w/ Rake @ Subsample Site:	5	2

SPECIES INFORMATION

Species Code	V	R 1	R 2	QE	Voucher
CERDEM	1	5	2	0	0
POTILL	1	1	–	0	0
NYMODO	3	1	1	0	0
MYRSPI	1	–	–	0	0
LEMMIN	1	–	–	0	0



Each subsampling area is 1.5 m long X 0.36 m wide.

Comments:

REMINDER INFORMATION

Substrate:
1 = Silt/Clay
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Voucher
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1 = Taken, not varified
2 = Taken, varified

Aquatic Vegetation Transect Site Data Sheet

State of Indiana Department of Natural Resources

ORGANIZATION: V3 Consultants

DATE: 7/18/03

SITE INFORMATION

Transect ID: T6

Site ID: 03

Substrate: 1

Marl? 0

High Organic? 1

Waterbody Name: Center Lake

Waterbody ID:

Total # of Species 3

Canopy Abundance at Site

S: 2 N: 0 F: 2 E: 0

SITE COORDINATES

Latitude: 41° 14.548 N

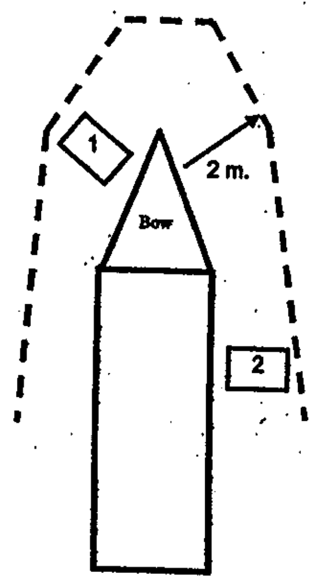
Longitude: 85° 51.390 W

SUBSAMPLE SITE INFORMATION

	1	2
Water Depth @ Subsample Site:	5.0'	5.1'
Plant Density w/ Rake @ Subsample Site:	5	1

SPECIES INFORMATION

Species Code	V	R 1	R 2	QE	Voucher
NYMODO	2	-	1	0	0
POTILL	2	1	-	0	0
CERDEM	1	5	2	0	0



Each subsampling area is 1.5 m long X 0.36 m wide.

Comments:

REMINDER INFORMATION

Substrate:
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2 = Silt w/Sand
3 = Sand w/Silt
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5 = Gravel/Rock
6 = Sand

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QE Code:
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Voucher
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1 = Taken, not varified
2 = Taken, varified